OIL, GAS AND PETROCHEMICAL PROCESSING

Petroleum Refiner

JULY
1959

SPECIAL COST REPORT

Distributing Auxiliary Costs 119
Inflation-How Much to Allow 113
Pitfalls to Rate of Return 117

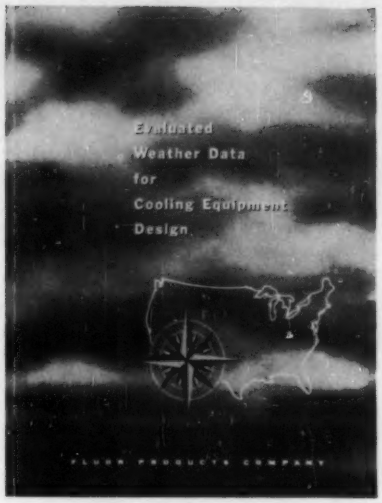
ALLOY KNOW-HOW
Metallurgy of Stainless Steel 131

SHORTCUTS
Selecting the Best Insulation 173

YOUR CAREER
Should You Take That New Job? 241

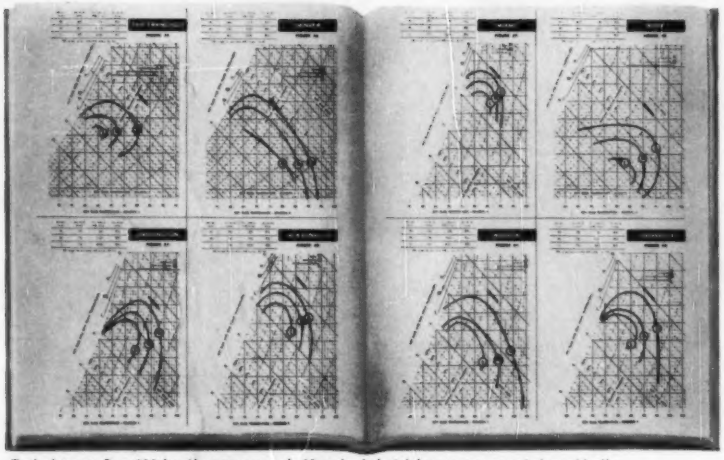
For a "Quick Look" at this issue, turn the page...

SUBSCRIPTION PRICE $2 PER YEAR
SINGLE COPY PRICE 50 CENTS



At last a book that enables accurate specifying of cooling tower needs

EVALUATED WEATHER DATA FOR COOLING EQUIPMENT DESIGN



Typical pages. Over 400 locations are covered. 49 major industrial areas are presented graphically.

This is the most comprehensive and useful compilation of weather data ever published for the user of evaporative heat exchange equipment. It enables engineers in every part of the country to calculate cooling tower requirements correctly. It ends speculation in the sizing of equipment.

From years of cooling tower experience, the Fluor Products Company has realized that compiled weather data — *if truly adequate* — would solve a major problem shared by manufacturer, design engineer and user alike. To achieve this needed scope, Fluor utilized modern electronic data processing techniques to digest and tabulate five to fifteen years of hour-by-hour summer-season observations from over 400 weather stations—a total of 10,000,000 evaluated statistics.

EXAMINE THESE EXAMPLES OF THE BOOK'S VALUE

WET BULB TEMPERATURES

Hourly observations are tabulated for June, July, August and September, a total of 2,928 hours per year per location. Number of hours are tabulated during which wet bulb temperatures equal or exceed any particular value. Also shown are wet bulb temperatures equaled or exceeded by 1%, 5%, 15% and 50% of the total hours of the summer months. The first three frequency levels are also presented in iso-line map form.

COINCIDENT DRY AND WET BULB TEMPERATURES

Coincident presentation is given because the maximums in wet-bulb and dry-bulb temperatures do not occur concurrently in most locations. On psychrometric charts three lines are shown: an "H" line enclosing 99% of total summer hours, an "M" line enclosing 95%, and an "L" line enclosing 85%. The 5-degree dry-bulb range is denoted during which wet bulb extremes are most likely.

WIND DIRECTION AND VELOCITY

Wind coincident with high wet bulb temperature is shown in tabulated and graphic form. It is obvious that wind vitally affects the location and orientation of natural draft cooling towers—but it also affects mechanical draft towers since part of the moist, warm exhaust air may be caused to reenter the tower. Also, three frequencies of both wind direction and velocity are presented.

Other information presented includes influence of adjacent operations, terrain, vegetation, etc., and methods of interpolation between geographical locations and elevations.

A limited number of copies are available for qualified consultants, design engineers, and cooling-tower users. Please make requests on company letterhead and indicate title or position.

FLUOR PRODUCTS COMPANY
BOX 1267A • SANTA ROSA, CALIFORNIA

Fluor PRODUCTS COMPANY

A DIVISION OF THE FLUOR CORPORATION, LTD.

Volume 38, No. 7 July 1959

SPECIAL COST REPORT

Foreword 109
How to Distribute Auxiliary Costs 110
W. H. Stanton
Include Inflation in Cost Accounting 113
F. C. Jelen
These Factors Affect Rate of Return 117
Louis P. Karvelas and Dale O. Cooper
How Du Pont Saves Money with Models 121
Lee R. Myers
Find Air Conditioning Costs Quickly 123
N. H. Prater and D. W. Antonacci
Optimum ΔP Cuts Exchanger Cost 129
William J. Baker

OTHER TECHNICAL ARTICLES

The Metallurgy of Stainless Steel 131
Frans R. Brotzen
Ks for Aromatics 137
D. S. Hoffman and J. H. Weber
How Statistics Improve Lab Efficiency 139
Maxey Brooke
New Way to Continuous H_2S Analyses 143
Ernest R. Quiram
Heat Transfer Nomographs (Part 10) 145
Jose Alvarez C. and Carlos Dubne
Atlantic Cuts Maintenance Costs 147
E. R. Schauffele and H. W. Parsons
Figure Distillation This New Way (Part 2) 151
W. N. Lyster, S. L. Sullivan, Jr., D. S. Billingsley and C. D. Holland
New Unit Gives 110 F-1 O.N. Alkylate 157
Edwin K. Jones
Additive Gives Octanes at Low Cost 159
Robert S. Aries
Applied Hydrocarbon Thermodynamics (Part 11) 161
Wayne C. Edmister
Adsorption Units—What's the Payout? 169
Fred H. Plitt
Shortcuts to Insulation Selection 173
L. L. Leach, Jr.
Taking Stock 178

As Management Sees It . . .

Should You Accept that New Job? 241
Charles C. Cleland and Robert F. Peck
The ABCs of Salary Administration 245
Richard B. Blomfield
Put Safety on a Personal Basis 254
J. B. Hamblen

DEPARTMENTS

LOOK BOX, Featuring . . .
Featherbedding a Common Enemy 13
Daniel P. Loomis
CONSTRUCTION BOXSCORE, Featuring . . .
Now New Refineries are Nearer Market 216

Quick Look at Industry .. 9
Mail Box 107
Valuable Reading Ahead 180
New Books 182
How To Do It 184
Who's Building 192
Construction Boxscore .. 216
What's Happening 264
Meetings Calendar 276
Men in Industry 277
Suppliers Notes 288
Classified Advertising .. 297
New Equipment and Literature 298
Advertising Index 316

PETROLEUM REFINER, published on the 12th day of each month. Second class postage paid at Houston, Texas.

Petroleum Refiner
OIL, GAS AND PETROCHEMICAL PROCESSING

©Gulf Publishing Company, 1959

SPECIAL COST REPORT

☐ **How to Distribute Auxiliary Costs . . .** presents a real problem in evaluating capital projects. Return on investment is greatly affected by the method used for charging utility costs. For a method for allocating these charges, turn to Page 110.

☐ **Include Inflation in Cost Accounting . . .** The hidden expense for inflation has been underestimated in the past. The allowance for inflation as presented here is an analysis based on the dollar as a variable. For a system which embraces the entire inflation problem, turn to Page 113.

☐ **These Factors Affect Rate of Return . . .** Just how good is interest rate of return for evaluating investment projects? For a guide to its use as well as tips on its shortcomings, turn to Page 117.

☐ **How Du Pont Saves Money With Models . . .** The proper use of models gives a better arranged and more economical plant design in less time with lower engineering costs. For a run down on how these economies have been accomplished, turn to Page 121.

☐ **Find Air Conditioning Costs Quickly . . .** presents charts and design data for rapidly estimating the costs for industrial air conditioning systems. Save yourself lots of time, turn to Page 123.

☐ **Optimum ΔP Cuts Exchanger Cost . . .** Optimizing pressure drop gives smaller, better operating and cheaper exchangers. For data and examples to help in this economic evaluation, turn to Page 129.

☐ **The Metallurgy of Stainless Steel . . .** An up-to-date review of what happens inside stainless and the effects on its properties brought about by adding various alloying elements. For instance, just what is sigma phase and how does it effect stainless? For a comprehensive but simple explanation, turn to Page 131.

Please Turn Page →

Pacific Process Pump **EXTRAS** bring **EXTRA PROFITS** to you!

is an extra feature in

PACIFIC PROCESS PUMPS

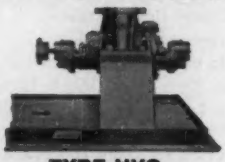
EXTRA CORROSION ALLOWANCE—All Pacific Process pumps are custom-built with case casting thickness in excess of actual pressure-temperature requirements. This provides a liberal allowance for corrosion-erosion and a high safety factor.

EXTRA HEAVY CONSTRUCTION—Pacific process pumps are engineered to combine the strength necessary for continuous heavy duty service with design simplicity and accessibility for low maintenance cost. All parts in contact with pumped liquid may be fabricated from any commercially available ferrous or non-ferrous metal.

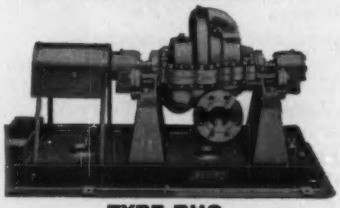
EXTRA LONG LIFE—Guided inlet flow reduces friction losses—insures minimum required NPSH. Dynamically, radially, and axially balanced moving parts eliminate vibration that would cause damage to rings, bushings, bearings, packing or mechanical shaft seals and excessive radial and thrust loads on bearings. Result—greatly increased availability for profitable operation.

Write for bulletins—please specify pump type.

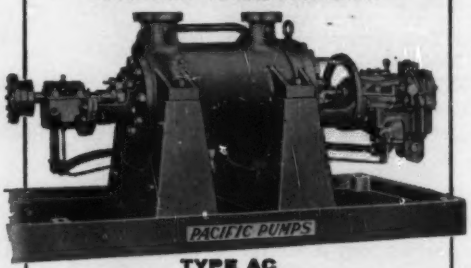
TYPE SVC
To 850°F.—25 to 3200 GPM
To 600 PSIG—To 650 DIFF. HD. FT.



TYPE HVC
To 850°F.—600 to 4500 GPM
To 600 PSIG—To 1000 DIFF. HD. FT.



TYPE RHC
To 500°F.—50 to 3000 GPM
To 700 PSIG—To 1300 DIFF. HD. FT.



TYPE AC
To 850°F.—100 to 2500 GPM
To 1000 PSIG—To 2600 DIFF. HD. FT.

PACIFIC PUMPS INC
A Division of Dresser Industries, Inc.
HUNTINGTON PARK, CALIFORNIA

PACIFIC

Offices in All Principal Cities

CP-19

A Quick Look at This Issue . . .

☐ **K's for Aromatics . . .** If you need equilibrium vaporizations for toluene, ethylbenzene or cumene, you will find them here over a wide temperature range of 60° to 460° F and pressures up to 350 psia. You've been looking for these to complete your K notebook. See **Page 137.**

☐ **How Statistics Improve Lab Efficiency . . .** Using statistical methods need not involve long detailed mathematical computations. For simplified methods which can quickly determine quality of tests, plus samples and tester competance turn to **Page 139.**

☐ **New Way to Continuous H_2S Analyses . . .** If you need a continuous record of the hydrogen sulfide concentration in one of your process streams, look into this radiation technique. The simple, convenient source of radiation is Iron-55 and a Geiger-Mueller tube is used to measure energy of radiation. Now you can obtain satisfactory information for billing purposes or to check plant operation, by reading this article which starts on **Page 143.**

☐ **Heat Transfer Nomographs** (Part 10) . . . **Vapor Condensation for Saturated Gases** . . . Here are two nomographs for the solution of heat transfer problems involving condensation of saturated vapors. These short-cut nomographs are real time-savers. This will complete your heat transfer design notebook, so turn to **Page 145.**

☐ **Atlantic Cuts Maintenance Costs . . .** To reduce maintenance costs, Atlantic's Philadelphia refinery consolidated and reduced its maintenance force to a minimum. This required two important steps: a good preventive maintenance program and technical assistance for the maintenance department. For complete details, turn to **Page 147.**

☐ **Figure Distillation This New Way (Part 2) . . .** In the first part, you read about a new convergence method for making multicomponent distillation calculations on a digital computer. In this second part you'll learn how to extend the method to include product purity as one of the specified conditions. Turn now to **Page 151.**

☐ **New Unit Gives 110 F-1 O.N. Alkylate . . .** Leonard Refineries incorporated the latest design factors in its HF alkylation unit. In this article you'll get a complete description of the unit and its high octane product, plus blending data to show the value of the alkylate as a motor fuel stock. Turn now to **Page 157.**

☐ **Additive Gives Octanes At Low Cost . . .** Tertiary butyl acetate can be used as an antiknock additive having greater effectiveness as octane levels increase. Tentative economics show how you can use the new additive to supplement expensive processing. See how the additive increases both laboratory and road octane ratings. Turn to **Page 159.**

☐ **Applied Hydrocarbon Thermodynamics** (Part 11) . . . **Flow Calculations for Gases and Gas-Liquid Mixtures** . . . Wayne Edmister applies thermodynamic relations and the exponents previously developed to the problems of compressible flow. Here he covers nozzle flow, pipe flow and diffuser flow. You'll find graphical and analytical solutions, plus methods and equations for most of your special cases. He gives illustrated problems and solutions too, so be sure to see **Page 161.**

☐ **Adsorption Units—What's the Payout? . . .** Here's a good place to start your economic evaluation of that lean gas field. You'll get a full run down on the effect of gas charge and liquid recovery on investment and payout. Turn now to **Page 169.**

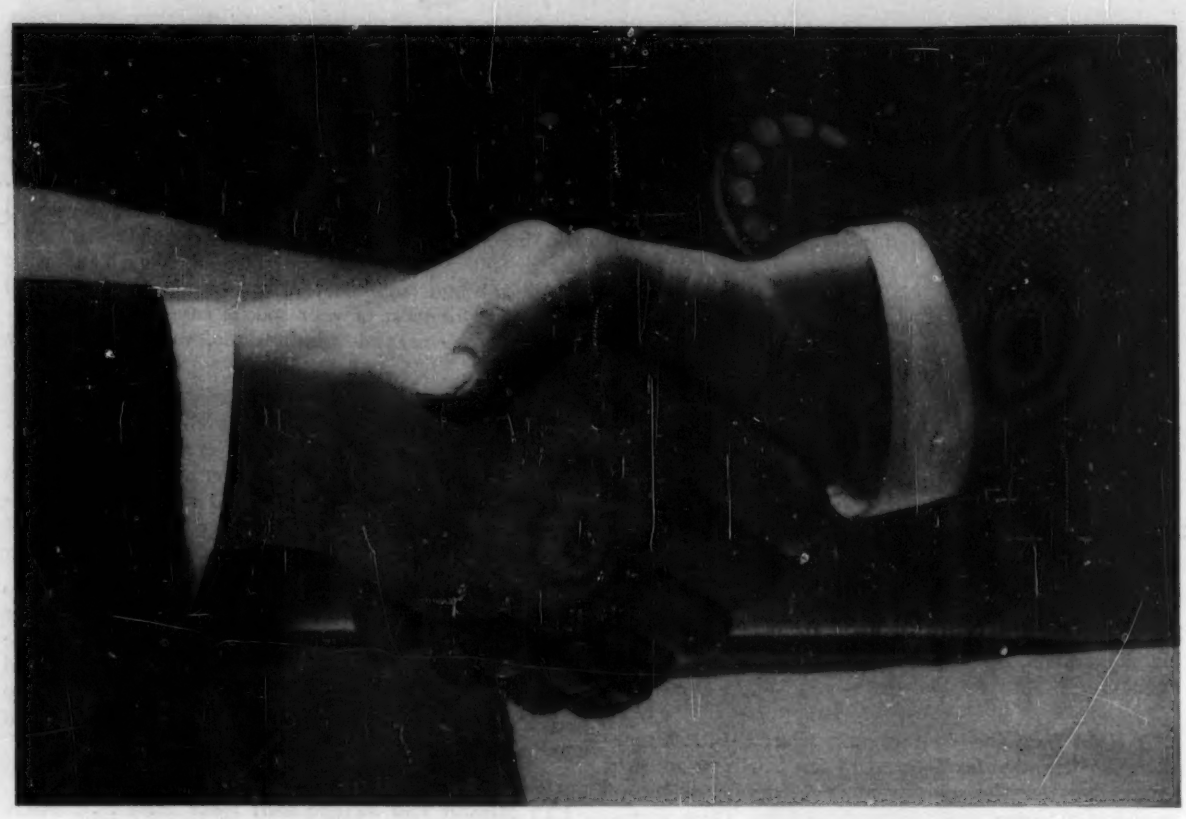
☐ **Shortcuts To Insulation Selection . . .** Since no universal perfect insulant exists, you must consider several factors when selecting insulating material. The first step is to consider service temperature carefully and not rely too heavily on the time honored K factors. To see how you can take this and the other steps easily, turn to **Page 173.**

☐ **Should You Accept that New Job? . . .** There is no doubt that one of the most important problems you and your family will ever have to face is that of changing jobs or choosing between several job offers. Here, however, is a good logical approach which will certainly go a long way in helping you make your decision. You're going to want to clip this article and keep it handy, so turn to **Page 241.**

☐ **The ABCs of Salary Administration . . .** A good program of salary and benefit compensation will result in increased employe morale and added management incentive. However, this program must be administered with minimum control and in such a way that it grants special recognition for individual performance. Here's an article you're going to remember for a long time so be sure to turn to **Page 245.**

☐ **Put Safety On A Personal Basis . . .** Accidents were increasing at Amoco's El Dorado refinery until management discovered that only 4.3 percent of the injuries was due to some failure of equipment. This was the beginning of a "personalized" safety program which has resulted in the fact that today, employes at that plant are five times safer at work than they are off the job. You'll read all about it starting on **Page 254.**

☐ **Nomograph Award for PR Authors . . .** Once again the ability of REFINER authors is acknowledge by an industry award. This time they are engineers Schweppe, Ritter and Lenoir, who authored the best nomograph published in 1958. For all the details, turn to **Page 277.**



You have our pledge...there is no compromise with quality when you order Refinery Supplies from "Oilwell"!

The service you get from the products you buy through "Oilwell" is just as important to us as it is to you. We know that you expect quality . . . and we assure you we deliver exactly that.

Oil Well Supply has been meeting the needs of the petroleum industry for 97 years. We feel we have learned, in that time, the difference between the product that will merely do a "passable" job and the product that will do the *best* job. We are convinced that operators want the *best* . . . so that is what we give them.

For pumps, valves, flanges, fittings, and for the many replacement items required to keep equipment operating at peak efficiency, contact your "Oilwell" representative.

USS and "Oilwell" are registered trademarks

Oil Well Supply Division of United States Steel

USS

Executive Offices—Dallas, Texas
Export Office—30 Rockefeller Plaza, New York 20, N. Y.

Quality Products of these and other manufacturers are sold by "Oilwell"

Catawissa Valve and Fittings Co.
Lunkenheimer Company
Manning, Maxwell & Moore, Inc.
Taylor Forge & Pipe Works
Thermoid Division
H. K. Porter Company
Henry Vogt Machine Company
Walworth Company
Watson-Stillman Division
H. K. Porter Company
Wilson-Snyder Works
Oil Well Supply Div., U.S.S.
Worcester Valve Co., Inc.

For more data on advertised products, use Readers' Service Cards, last page.

Petroleum Refiner

RAY L. DUDLEY, Founder, 1891-1957

WILLIAM G. DUDLEY.....Publisher
TOM W. NELSON.....General Manager
R. M. DE SOMBRE.....Assistant General Manager
SILAS B. RACSDALE.....Editorial Director
DR. JOHN J. MCKETTA, JR.....Chairman of Editorial Committee
GEORGE B. GIBBS.....Editor
FRANK L. EVANS, JR.....Maintenance and Design Editor
HAROLD L. HOFFMAN.....Process and Construction Editor
THOMAS C. PONDER.....Petrochemicals Editor
CLAYTON A. UMBACH, JR.....Management and Personnel Editor
DR. LEWIS F. HATCH.....Contributing Editor
WALLACE FITZGERALD.....Managing Editor
JACK COCKERHAM.....Presentation Editor
CHARLES VERVALIN.....Editorial Assistant
VAN WILLIAMS.....Editorial Assistant
DOLORES REYNOLDS.....Editorial Assistant
EUNICE OKONESKI.....Librarian

ADVERTISING

Gene Hart, Advertising Sales Manager, Box 2608, Houston. *Representatives:* HOUSTON 19: Jack Walker, 3301 Buffalo Drive. Phone JA 9-4301; NEW YORK 17: George Skelton, Al Lucadamo, 250 Park Ave., Phone YU 6-6550; CLEVELAND 16: Harvey Dunn, 20800 Center Ridge Rd., Phone EDison 3-1650; CHICAGO 46: Martin Halloran, 6039 North Cicero Avenue, Phone AVenue 2-4333; LOS ANGELES: Jay Curts, Jim Merrill, W. W. Wilson Bldg., Huntington Park, Phone LUdlow 7-1219; TULSA 3: Jim Isaacks, 916 Enterprise Bldg., Phone CH 2-9211; DALLAS 2: Ed Thompson, 1800 Sylvan Drive, Phone Riverside 7-7344; EUROPEAN: Theodor Miocha, Agent, Limmerstrasse 31, Hannover, Germany, Phone 4-2935; UNITED KINGDOM: Frank Chambers, Agent, 120 Moorgate, London E.C.2, Phone Monarch 5661. Advertising rates on application. Cable Address: GULFPUBCO, Houston.

SUBSCRIPTIONS

F. G. Spindle, Subscription Manager, P. O. Box 2608, Houston 1, Texas, U.S.A. Single copies 50 cents (except special issues) for domestic and foreign. Double price for copies over one year old. Subscription rates—both foreign and domestic $2 a year. Subscriptions restricted to those engaged in oil, gas and petrochemical processing industries or service and supply company personnel connected thereto. Copyright 1959 by Gulf Publishing Company.

Postmaster: Send notification (Form 3579) regarding undeliverable magazine to Petroleum Refiner, Box 2608, Houston 1, Texas.

Specialized Oil Publications of
GULF PUBLISHING COMPANY
Box 2608, Houston (1), Texas

PETROLEUM REFINER and The REFINERY CATALOG for the oil, gas and petrochemical processing industry.

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry.

PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.

Petroleum Refiner is indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Michigan.

Real Togetherness

FOUR HUNDRED TWENTY consecutive issues containing one or more of their advertisements is the record which Elliott Company has established with PETROLEUM REFINER. The first issue containing an Elliott advertisement was 35 years ago, when world crude run to stills was 1 million barrels daily (it's 19 million now), and crude reserves were estimated at 15 billion barrels (with warnings on every hand that a shortage of petroleum was just around the corner). Now reserves are set at 232 billion barrels, which affords an index of the advances made by the petroleum industry in the face of the world's gain in motor vehicles (108 million now vs. 15 million in '24) and other factors which have upped fantastically the demand for petroleum. These include the thousands of products from petroleum, which weren't even dreamed of in the early twenties. "Thirty-five years ago few persons could visualize the magnitude, worldwide scope and remarkable technical developments of the oil, gas and petrochemical industry as we know it today," PR says on Page 232 in a salute to this longtime every-issue advertiser. And researchers indicate that actually we're just getting "good started." So try to imagine, if you will, the advances that PR will record in its next 420 issues!

Authoritative

WHEN THE *New York Times,* for its "Century of Oil" special section, was seeking an authority on petrochemicals in the United States, it beckoned to Tom Ponder, PR's very able Petrochemicals Editor. And Tom did a mighty nice job.

Then the same rather well known publication commandeered the services of Dr. John McKetta, chairman of our editorial committee, plus Management Editor Clayton Umbach for an article on the future of energy. Result, another bit of sound, interpretative writing.

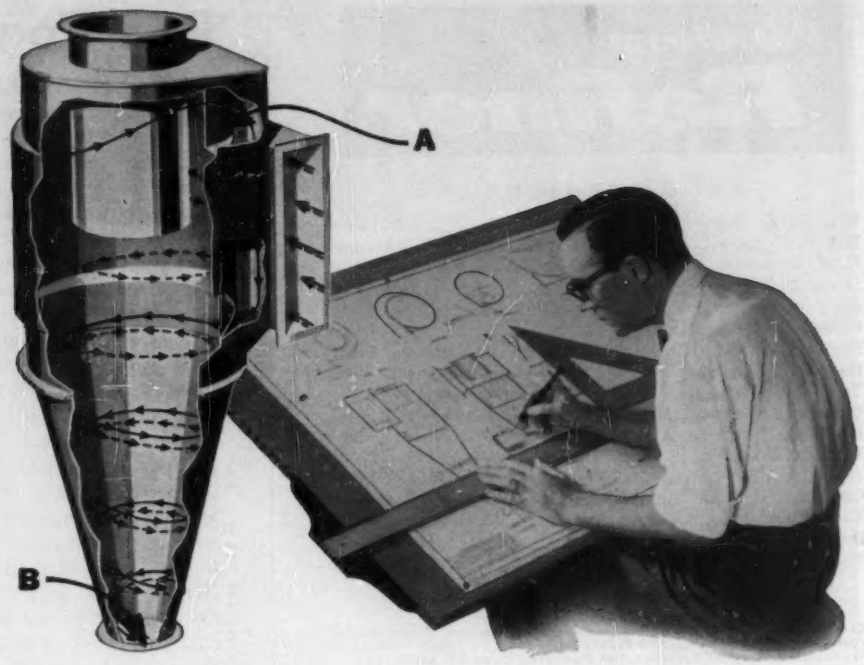
Exhibit 3 for today is the lead position given PR's recent market report by Armco Steel's magazine "Progress" in its feature article dealing with "Petrochemical Expansion." Capital expenditures as estimated by our editors looked mighty imposing.

All of which reinforces our claim that PR and its editors are the leading authorities in their fields. And are we proud of such recognition!

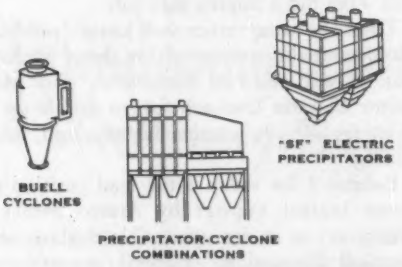
Top Award for Nomo

SOME READERS LIKE nomographs; some don't find them so convenient. But industry experts have advised us that if you publish a nomograph be sure it's top notch.

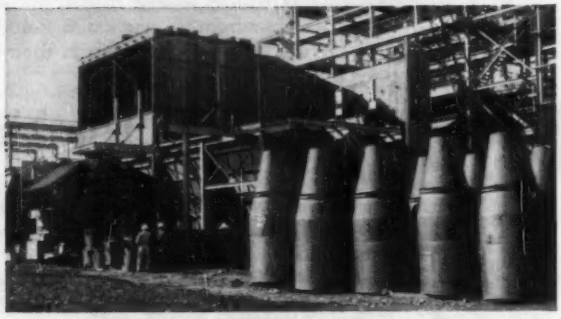
We try to follow this, and some mighty reputable judges say we did the best in 1958. PR authors Ritter and Lenoir of C F Braun & Co., and Schweppe of the University of Houston faculty, have been awarded the ASEE Division of Graphics award for the best nomograph published in 1958. ("Find Specific Gravities by Nomograph," November, 1958, issue.) Meet the authors again in "Men in Industry," Page 277.



The most efficient operating cyclone collectors made



Design makes the difference: in over a thousand plants across the continent, Buell Cyclones have *proved* themselves more efficient than any other cyclones made. Buell's exclusive Shave-off port (A), traps the extra percentage of dust that ordinary cyclones lose. And large-diameter, (B), custom-engineered design eliminates bridging, clogging, or plugging during operation, keeps efficiency high without interruption. Regardless of your present or planned plant layout, Buell equipment can be designed to solve your dust collection problems efficiently and economically. There's valuable information in a concise booklet, "The Exclusive Buell Cyclone". Write Dept. 21-G, Buell Engineering Company, Inc., 123 William Street, New York 38, N. Y.



Buell Cyclones before installation at a major plant.

buell®

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

Quick Look at Industry...

Long Range Octane Picture . . .

Discount talk that octanes have reached a peak in motor fuels. Cars in next five years expected to demand still higher octanes—both in Europe and in U.S. Also, look for Motor method of octane determination to get more important. Reason: growing number of cars part-throttle limited with respect to knock.

Part-throttle knock almost unknown till '58, but now affects one in every 20 late model cars says Du Pont. Type of knock depends largely on amount of vacuum spark advance in engines. Both Research and Motor octane numbers affect road octanes at full-throttle, but tests indicate Motor octane number is deciding factor in part-throttle knock. Thus, greater incentive for processes like alkylation.

As result, look for alkylation units to get larger—2 to 3 times bigger than before. In turn, this will increase demand for feedstock. Shift will be to high propylene content charge. Then watch shift to more C_4 isomerization to balance increase in olefin feed to alkylation.

Next World Petroleum Congress . . .

World Petroleum Congress next slated for Federal Republic of Germany. No date or city chosen yet, but normal 4-cycle indicates year will be 1963.

U.S. Petrochemicals Eye Europe . . .

By 1960, look for Western Europe to be petrochemically self-sufficient. In '58, West Europe petrochemical production increased by 30%—to 830,000 tons annually. By '60 expect production to hit almost 2 million tons yearly. Since this will shut off petrochemical imports into those countries, U.S. producers now edging in on market by building plants in Western Europe—many in joint ventures. Advantages: compete in common market; keep markets which would be lost through curtailed imports; return on capital investment without fighting currency problems.

Jets Creating Fuel Problems . . .

Fuel-hungry jets creating new problems for designers of diesel engines according to one authority. In past, most diesel engines used light fuels which were plentiful and relatively cheap. But jets demands boosted prices to point where heavy residuals are attractive to operators of medium and large diesel engines. Now reworking old designs to permit use of heavy resids.

Results Slow but Sure . . .

API study on hydrocarbon composition of single barrel of crude has lasted 33 years and cost more than $1 million. Results: identification of 169 hydrocarbons of the more than 1 million estimated to exist.

Benzene Purchase Draws Senate Fire . . .

Sen. Schoeppel (R-Kans.) publicly criticized on Senate Floor recent contract which saw Dow Chemical buy $13.5 million worth of Soviet-produced benzene. Said the Senator, "It is surprising to me and many others in the domestic industry that leading firms in American business

are purchasing Soviet-produced materials and products where there exists in this country, in some instances, an oversupply of the same product readily available for use."

X-rays Trace Fire Source . . .

X-ray diffraction techniques now being used in West Germany to trace sources of fire. Check of copper conductors reveals temperatures they experienced. Values then plotted in relation to building layout provide clues to where trouble began.

Petrochemicals Top Trend . . .

Survey of World Petroleum Congress delegates reveals increased emphasis on petrochemicals as most significant trend in world petroleum industry. Other trends:

1. Majority of delegates—more than 75%—look to U.S. for leadership in petroleum field.
2. By 1975 world's petroleum countries planning to increase petroleum production anywhere from 10 to 500%.
3. More than 75% of countries represented planning extensive capital expansion next year in petrochemicals, exploration, refining facilities, and storage terminals.

More Mergers on the Oil Scene . . .

Pauley Petroleum acquires Newhall Refining, Newhall, Calif.,—Newhall has 2,400-bpd refinery to be expanded by 50% . . . Signal Oil & Gas acquiring Eastern States Oil & Chemical—Signal gets modern 60,000-bpd refinery in Houston, plus petrochemical plant, research center, deep water marine terminals and interest in a pipe line. Earlier this year, Signal acquired recently burned refinery of Hancock Oil . . . Texaco and Superior Oil about to join in what looks like one of the biggest mergers to hit oil scene in long time . . . Western Natural Gas buys Premier Oil & Refining—Premier has 8,000-bpd plant in Ft. Worth, 5,000-bpd at Longview, and 1,200-bpd at Baird, Texas. Western Natural also recently got McBride's refinery at Brownsville.

Harder than Steel . . . Lighter than Aluminum . . .

Soviets claim new glass, Sital, harder than steel and lighter than aluminum. Say material has electrical characteristics better than ceramics, heat resistance superior to the best glasses and "does not soften even at 1,400°." Described as a microcrystalline glass containing particles of one micron size, Sital is produced by heat-treating glass with a "special composition" which renders its structure monocrystalline.

Quick Look Around the World . . .

Dow Chemical and Pacific Chemical and Fertilizer form new company, Hawaiian Extruders, Inc., to manufacture polyethylene film in Hawaii . . . Derby Refining becomes Division of Colorado Oil & Gas . . . Armour Chemical buys Mississippi River Chemical's 240-ton-a-day anhydrous ammonia plant near Festus, Mo. . . BuMines to reopen Navaho helium plant at Shiprock, N. M. . . . Foster Wheeler's plans for acquiring North American Aviation discontinued.

L. A. Limits Olefin Content . . .

Los Angeles County puts limit of 18% olefins on gasoline sold in county after June 30, 1960. By Jan. 1, 1962, content must be reduced to 12.5%.

Panning the Octane Postings . . .

Ethyl survey of major U.S. cities shows premium octane averaged 99.1 F-1 for June—unchanged from May. Regular inched up 0.1 octane to give a June average of 91.9 F-1.

Blaw-Knox uses a Royal Electronic Computer to speed material balance and energy calculations and to aid in equipment design. The Royal LGP-30 computes optimum design conditions for projects handled by the engineering, chemical process, and equipment design departments.

Blaw-Knox adds electronics to experience to solve your design-engineering problems

With electronic computation Blaw-Knox has again broadened the scope of its services . . . to explore and solve your process and engineering problems with new speed, new precision, and new economy.

With this time-saving tool, Blaw-Knox engineers can accurately examine and solve complex problems heretofore considered impractical to answer with precision. Your project's needs and their solution get new scrutiny. Optimum conditions are attained to give you a plant that's more economical to build, more profitable to run.

When you plan your next advanced process design, plant construction, expansion, or modernization, contact Blaw-Knox Company, Chemical Plants Division with headquarters in Pittsburgh. Branch offices in New York, Chicago, Haddon Heights, New Jersey, Birmingham, Washington, D.C., and San Francisco.

plant builders for industry . . BLAW-KNOX

For more data on advertised products, use Readers' Service Cards, last page.

Economic Way to Build a Refiner

Kellogg Turn-Key Plant for El Palito Assures Optimum Investment Return for Mobil Oil Company of Venezuela

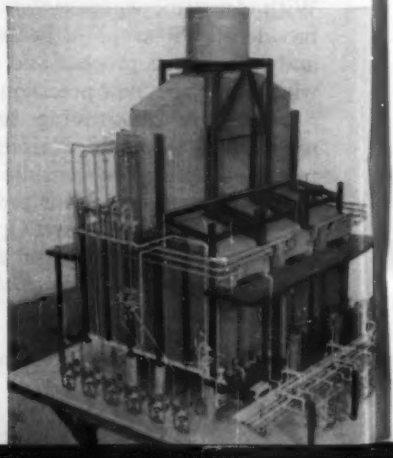
Many engineers are familiar with the phrase, "a turn-key plant", used when complete responsibility for a new refinery is given to a single engineering and construction firm. In such cases, the one firm handles all aspects of engineering, scheduling, purchase and transportation of materials, and erection.

In effect, the contractor hands over the key to the refiner, delivering a completed and fully operable plant.

The many advantages of a turn-key plant were apparent to Mobil Oil Company of Venezuela when planning its new 50,000 BPD refinery at El Palito. Complete responsibility for the project was awarded to Kellogg. The products of the refinery, which is designed to operate on Barinas crude, will include Mobilgas, Mobilgas Special, kerosine, jet fuel, middle distillate, and heavy fuels.

If you are planning to expand refining facilities in any part of the world, the Kellogg organization welcomes the opportunity to prove the economies of working with its engineers on the most suitable process units or combination of units.

One of the many techniques being employed by Kellogg to achieve the optimum plant for Mobil is its system of designing directly on models. Above: designers are shown working simultaneously on sections of the El Palito refinery. Models such as these reduce engineering time, improve designs, minimize drawings, facilitate approvals, and contribute to an earlier on-stream date. Below: Kellogg's model of the crude oil furnace in close-up, showing the fine detail of technique.



THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Co., Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., Buenos Aires
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

Featherbedding a Common Enemy

Daniel P. Loomis, President, Association of American Railroads, Washington, D. C.

THE NATION'S RAILROADS are plagued with a labor relations problem that the petroleum industry could well take time out to examine. Ironically, the problem results in part from the railroads' technological advances—the laudable attempt to do a better job for the public at less cost—an unfolding drama which has substantially paralleled the many technological advances in petroleum.

The problem is featherbedding—pay for work not done or not needed. "Make work" and "payroll padding" cost the railroads more than $500 million a year and hit the whole nation as those who ship or travel pay the bill in freight rates or passenger fares. Not only that, but featherbedding generates inflationary pressures in just this measure—and at a time when we need inflation like we need a hole in the head!

A prime example of featherbedding is found in the fireman position on the diesel locomotive. Unlike the bygone steamers, diesels have no fires to stoke and no boilers to tend. But the featherbedding rules ignore such practical changes and force the lines to keep this unneeded employe in the diesel cab—even on freight trains where an engineer and head-end brakeman are already on hand.

Outmoded Controls. Featherbedding has its roots in work rules written into labor contracts 40 or more years ago. Yet they have remained largely unchanged despite all the modernization and change the railroads have undergone in those years! For example, the puffing steam locomotive has almost passed into history, train speeds have nearly doubled, and train operating methods have undergone a complete overhaul with the extensive installation of electronic traffic control systems and pushbutton yards.

But the outmoded rules remain fixed and inflexible, siphoning off much of the benefits yielded by modernization. The net effect is that today's iron horse remains tied to a 1919 hitching post.

Here are some other classic examples of the effects of the archaic make-work rules:

1. A veritable Chinese Wall is erected between road crews and yard crews, with each forbidden to work in the other's domain except at great penalty to the railroad. This can lead to the carriers paying two, three and even four times for single-time work. In one referee's precedent-setting interpretation which has bled the railroads, a yard worker was given an extra day's pay for working a few minutes on a line outside the yard limits; at the same time a road employe received a day's pay for the work he did not do but claimed he should have done. There you have three days' pay for one piece of work—two for the yardman, one for the roadman.

2. Twenty-three states, by statute or regulation, require extra brakemen or other unnecessary trainmen, generally on freight trains. This is on the specious assumption that they are needed for safety, a relic of turn-of-the-century thinking when brakemen had to race back and forth and operate freight brakes by hand. Of course, automatic power air brakes now do the job, and far better!

3. With the steady increase in train speeds, passenger engineers now draw a basic day's pay for an average of only three hours work. Some get it for only two hours work. The average freight engineer gets a basic day's pay for only four hours work. Yet the whole dual pay system was drawn up specifically on the basis that a fair day's work equals a fair day's pay.

Can you think of a better way to go broke?

How efficient would an oil refinery be if it had to operate by 1919 standards? Think how operating costs would rise if labor costs on refinery runs were figured on the same basis as railroad wage costs on train runs!

Payroll Padding. For example, what would it do to oil company profits if you had to pay a full day's basic wage to refinery men for 90 minutes work, as the railroad does in a streamliner speeding from Minneapolis to Willmar, Minn.?

Or 2¼ days' pay for a four-hour trip, as the railroad does between New York and Washington?

Or nine days' pay for a 16-hour run from New York to Chicago?

Not only the public and the railroads suffer from featherbedding. By an ironic twist, railroad labor is perhaps the biggest loser of all. A half-million rail-

McKee construction force at Inland Steel Company sets a

SAFETY RECORD OF 1,000,000 MAN-HOURS

Working on the most hazardous types of heavy steel mill construction work, a McKee field force of more than a thousand men made this remarkable record at the Inland Steel Company's plant at East Chicago, Illinois. It was accomplished on operations in which a high accident rate is normally expected —pile driving, hydraulic dredging, excavating, foundation construction, steel erection and machinery setting.

The McKee field force made major repairs, replaced foundations, installed new equipment and constructed new facilities while the plant continued to operate. Even though much of this dangerous work was done on the night shift, not a single man-hour was lost as a result of a disabling accident, according to records kept by National Safety Council standards.

This record would not have been possible without complete cooperation between Inland officials, the AFL Craft Unions and McKee personnel. We are particularly proud of this performance because it demonstrates the care and efficiency in engineering and construction with which the McKee organization serves its customers.

ARTHUR G. McKEE & COMPANY • 2300 Chester Avenue • Cleveland 1, Ohio

OFFICES IN: CLEVELAND
NEW YORK • WASHINGTON
UNION, N.J. • HOUSTON, TEX.
TORONTO: ARTHUR G. McKEE & COMPANY OF CANADA, LTD.
ENGLAND: HEAD, WRIGHTSON & CO., LTD. (BRITISH REPRESENTATIVES OF METALS DIV.)

McKEE ENGINEERING AND CONSTRUCTION SERVICES

road jobs have disappeared since World War II. And, I predict that unless the featherbedding problem can be solved, "more thousands of jobs will go down the drain."

Featherbeds are also a threat to national defense. Draining off more than $500 million a year in waste, they leave most carriers with not enough earnings to buy needed replacements of cars and other equipment or make other essential plant improvements. In World War II the railroads handled 90 percent of all domestic shipments of Army and Navy ammunition, equipment and supplies and 97 percent of all organized troop movements in this country.

The lines' passenger-carrying fleet is now 40 percent smaller than the one that saw such Herculean service in World War II. The Pentagon is so concerned about this deteriorating situation that it is stockpiling cars on its own.

The moral of all this for people outside the railroad field is that "it could happen here." Among other industries that are plagued by featherbedding are entertainment and broadcasting, printing and publishing, and construction and home-building. If the railroads manage to wipe out this blight, it could point the way for effective action in industries similarly bedeviled.

Latest Proposal. A railroad labor-management agreement of almost three years ago established a moratorium on work-rule changes until October 31, 1959. Hoping to modernize the rules in a way equitable to all, management in February made overtures to the five Brotherhoods concerned with train operations where most featherbedding is concentrated. Management suggested that labor join in a request to President Eisenhower to establish a special commission of distinguished, impartial citizens to study the problem and recommend ways to solve it in the public interests.

The unions' reaction? Hysterical shrieks, name-calling and an insistence that featherbedding is no concern of "the politicians" or the public. The proposed joint appeal for public study, it would seem from their labored refusal, would be beneath the Brotherhood chieftans' dignity.

But back to the public interest. Here are some facts of life that all, including labor leaders, can see at a glance:

1. Railroad revenues come from the public.
2. The people, therefore, pay the bill for featherbedding whether this comes in inflated prices, reduced employment or weakened public transportation services.
3. If the Brotherhood chiefs' dog-in-the-manger attitude brings on a strike, the public will pay again in widespread economic disruption and personal hardship.

Railroads and railroad thinking must advance with the times. This is 1959. Yesterday is gone forever; 1919 was four decades ago—the past should be buried!

Centennial Stamp Ready

THE POSTAL AUTHORITIES have released a picture of the special 4-cent stamp which has been designed to commemorate the Centennial of the petroleum industry. As you can see, the stamp portrays a derrick pumping oil into storage tanks and includes the words "Petroleum Industry."

Regretfully, we cannot help but feel somewhat disappointed in the final design. The stamp is dull

and lifeless and it seems to us that the designer should have included a sketch of the Drake Well, a refinery process unit, or perhaps a car, ship or jet aircraft to illustrate some of the uses of petroleum. These items might have been woven into an attractive stamp which we believe would aptly illustrate the important role oil has played in the industry and economy of this country.

Of course, hindsight is never less than 20-20 but we sincerely feel the designer could have taken a tip from the medallion on the January issue of PETROLEUM REFINER. Take a look and see if you don't think it did a much finer job of telling, in a small area, the oil story.

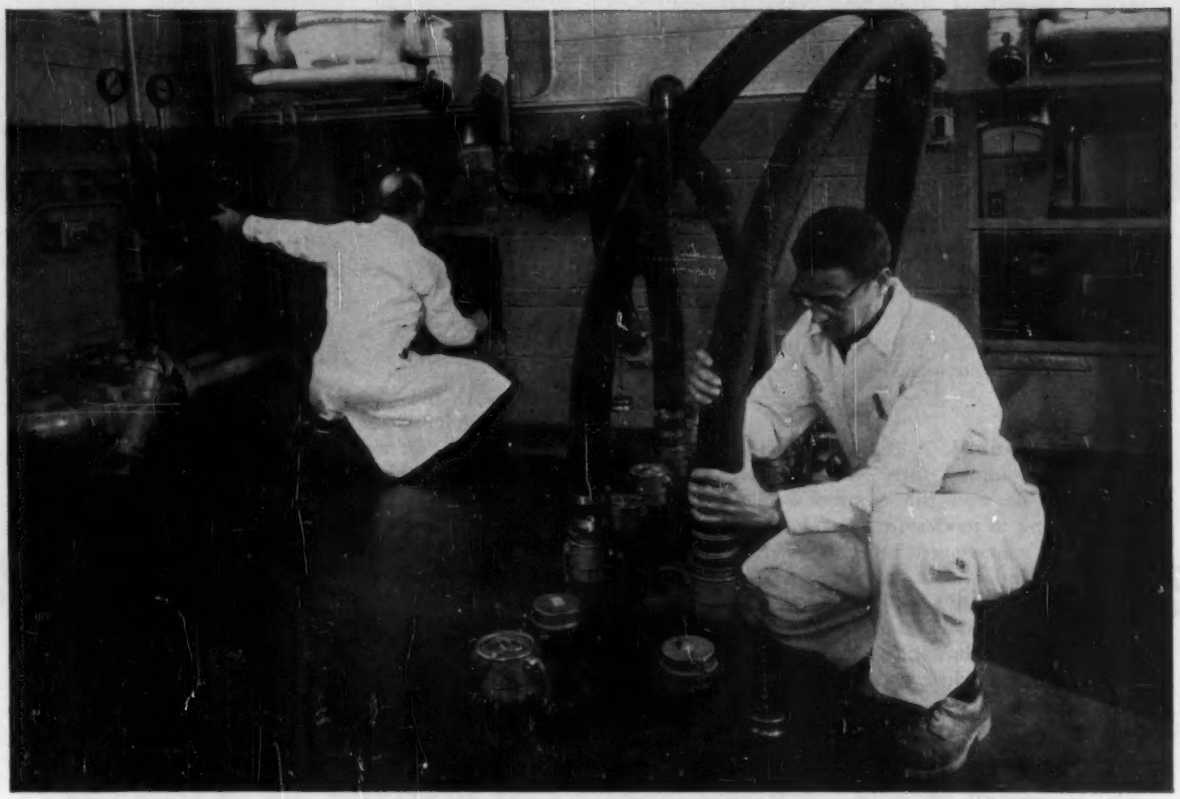
Be that as it may, however, 1959 is the Oil Centennial year and this is the official stamp. If you, or any of your friends, are stamp collectors and wish to obtain a first-day cancellation, you may do so by sending 10¢ and a self-addressed stamped envelope to: First Day Covers Petroleum Industry Stamp, Postmaster, Titusville, Pa. Be sure to place a close-fitting enclosure of postal card thickness in each envelope and either turn the flap down or seal it. Don't delay though—release date is August 27.

"I can't refrain from pointing out that if it were not for this technical progress, our costs today would be far higher and our need for rate increases far greater . . . What inflation does is eat up the dollar savings that come from technical gains . . . . If it were not for inflation, I'm sure in my own mind that this kind of progress would take us far along the road to lower prices, better earnings—in fact better everything for everyone. But inflation erases the economic gain and thereby puts a penalty on us all."

—FREDERICK R. KAPPELL, President,
American Telephone & Telegraph Co.

ETHYL ADDITIVE RESEARCH ...The final answer is on the road

In 1958, Ethyl's test cars and cooperating car and truck fleets logged over eight million miles on the road in evaluating fuel and lubricant additives.



Here Ethyl technicians control gasoline blending with laboratory accuracy, in quantities up to 10,000 gallons.

Why Fleet Evaluation

Prospective additives for fuels and lubricating oils require extensive testing and evaluation before being made available commercially.

In addition to evaluating their effectiveness on their prescribed job, additives are checked for possible detrimental effects such as reduced valve and spark plug life, engine wear and increased combustion deposits.

Initial screening is performed in the laboratory through chemical and engine tests. But the final answer comes from broad-scale investigation under actual use conditions.

The development of a successful additive requires careful study before it can be marketed with the assurance that overall behavior is beneficial. Durability aspects are perhaps most important since very small concentrations of certain chemicals may either greatly improve or reduce engine life.

As an example, the figure shows data from passenger car fleet work on seven different experimental fuel additives. In this study, exhaust valve life was evaluated under heavy duty road operating conditions.

Blending for Fleet Tests

Fleet work requires large quantities of test fuel that must be blended with laboratory precision to eliminate variations in additive concentrations.

To provide accurate test fuel blends for passenger car and truck fleets, Ethyl maintains blending plants at Detroit, San Bernardino and San Antonio.

At these plants, experimental fuels are put together in batches ranging up to 10,000 gallons. Each blend must be prepared with the care and accuracy that is usually required only for laboratory work.

At Ethyl's Detroit laboratory, precision fuel blending equipment includes two positive displacement pumps, each capable of handling 230 gallons per minute; seven 10,000-gallon storage tanks which are interconnected to fa-

For more data on advertised products, use Readers' Service Cards, last page.

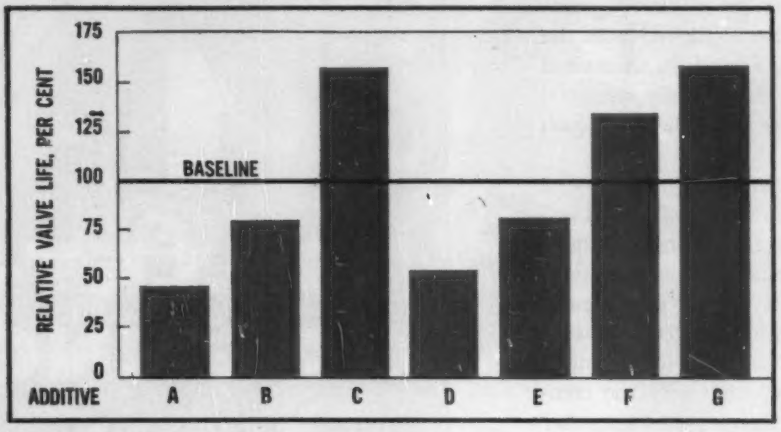
cilitate blending flexibility; and an accurate eductor and weigh-scale system for precise measurement of additives to be used in experimental fuel.

Fleet Tests for New Antiknocks

This equipment permits precise blending of Ethyl's experimental antiknocks for fleet study. The following engine aspects are evaluated on the road:

Inductibility
Engine wear
Oil oxidation
Octane requirement increase
Valve durability
Spark plug life
Surface ignition

Because of Ethyl's fleet work with the new manganese additive (AK-33X), a new antiknock is now on the commercial horizon. In many cases this new product will afford the refiner more economical octane numbers; in all cases it will give the refiner additional chemical octane flexibility for planning future gasolines.



Experimental fuel is transferred to a gasoline tanker.

How Ethyl Research can help you

Painstaking evaluation of every development step from the test tube to the cars on the road assures refiners that all new Ethyl products meet the criteria of commercial acceptability.

Ethyl Research Representatives are in direct contact with such research programs. As a result, they are able to maintain a continuous flow of up-to-date information to customer research people.

If you would like more information about the program that was used to evaluate the new manganese antiknock, contact your Ethyl Representative.

ETHYL
ANTIKNOCK COMPOUND
ETHYL CORPORATION

ETHYL CORPORATION
New York 17, N. Y.

Ethyl Corporation of Canada Limited, Toronto
Ethyl USA (Export) New York 17, N. Y.

RESEARCH LABORATORIES
Ferndale 20, Detroit, Michigan
San Bernardino, California

For more data on advertised products, use Readers' Service Cards, last page.

How lasting quality is bu
Heat Exchanger a

Fabrication of Phelps Dodge heat exchanger and condenser tubes starts with the casting of billets. In this process, high grade copper (over 99.90% pure) from Phelps Dodge's own mines is alloyed with the finest quality metals available. The alloys are melted in electric furnaces and cast in specially designed water-cooled molds that produce sound, homogeneous billets.

Each billet must conform to rigid Phelps Dodge standards, as well as to the requirements of ASTM and U.S. Government specifications. Strict control is maintained over every phase of the billet-casting operation.

Before melting, the metals to be alloyed are carefully weighed to their correct proportions in the cast billet. Each melt is carefully sampled for chemical and spectrographic analyses which verify the composition of the billet before it is released for further processing.

Throughout the entire tube fabrication—from raw materials to finished product—quality is the keynote. That's why Phelps Dodge tubes are preferred by those who demand the finest . . . the manufacturers and users of heat exchangers and condensers.

1

BILLET-CASTING

(FIRST OF A FIVE-PART SERIES)

Casting shop area in new Phelps Dodge tube mill at South Brunswick, N. J. This mill has the largest copper and copper-alloy tube capacity in the U. S.

Alloy proportions are carefully checked by spectrographic analysis to assure conformance with exact specifications.

For more data on advertised products, use Readers' Service Cards, last page.

is built into Phelps Dodge er and Condenser Tubes...

Close-up of casting operation shows molten metal flowing from electric furnace into specially designed molds.

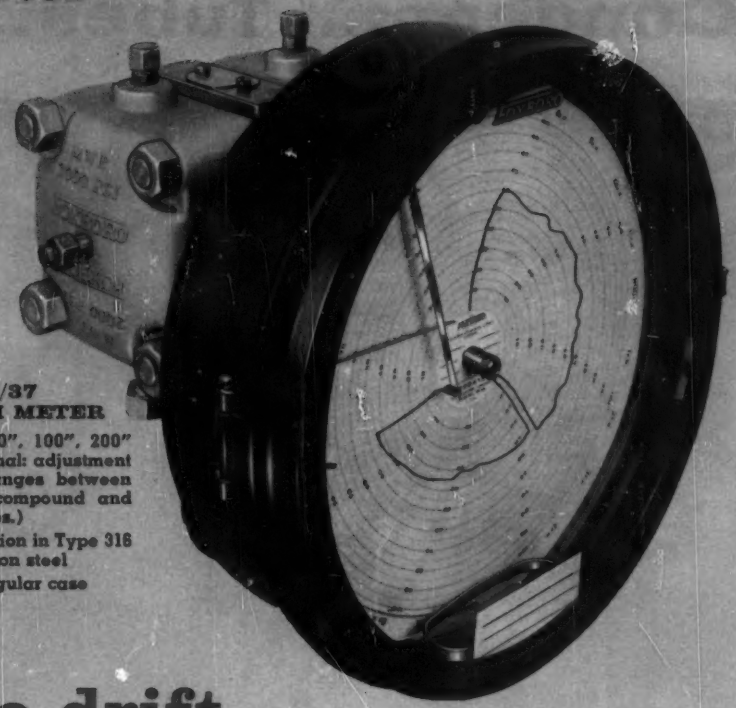
PHELPS DODGE COPPER PRODUCTS CORPORATION

First for Lasting Quality—from Mine to Market!

SALES OFFICES: Atlanta, Birmingham, Ala., Cambridge, Mass., Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Dayton, Denver, Detroit, Fort Wayne, Greensboro, N. C., Houston, Indianapolis, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.

For more data on advertised products, use Readers' Service Cards, last page.

unmatched stability in a "dry" flow meter



FOXBORO T/37 DIAPHRAGM METER

- Ranges: 20", 50", 100", 200" standard (Optional: adjustment for full scale ranges between 25" and 200"; compound and expanded ranges.)
- Forged construction in Type 316 stainless or carbon steel
- Round or rectangular case

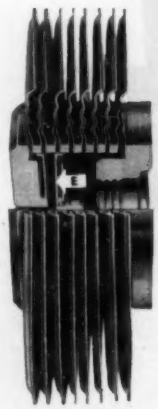
No zero drift... Complete overrange protection

Mercuryless flow measurement over a wide range of differential pressures — at static pressures up to 2000 psi (2500 psi optional). That's the story behind Foxboro's unique Type 37 Diaphragm Flow Meter.

No matter how often you check its accuracy you'll find no need to reset zero or span. Four vital construction features assure this remarkable stability:

1. Unique nesting diaphragm element of Type 316 S.S. which responds to changes in pressure with unmatched sensitivity yet cannot be damaged by overrange . . .
2. Packless drive bar which transmits precise linear motion to pen arm without "hang-up" . . .
3. Bi-metallic temperature compensator which precisely counteracts changing volume of the filling fluid . . .
4. Heavy Ni-span C alloy range springs which are unaffected by changes in line temperature . . .

Get full details on this high utility, completely dependable dry flow meter. Write for Bulletin 7-15A. **The Foxboro Company, 747 Neponset Ave., Foxboro, Mass.**



Type 316 S.S. diaphragm elements, in both high and low pressure chambers, provide greatest linearity and freedom from hysteresis. Nesting design, and integral spacer rings provide positive overrange protection. Bi-metallic temperature compensator (E) adjusts the capacity of the diaphragm assembly to counteract changing volume of the filling fluid.

FOXBORO
REG. U.S. PAT. OFF.
first in flow metering

"FRANKLY HOPWOOD,

DON'T YOU THINK IT WOULD BE MUCH MORE PRACTICAL IF WE SENT FOR **BRIDGEPORT'S** FREE NEW BOOK— 'SOLVING CORROSION PROBLEMS IN INDUSTRY'!"

If you convey anything through condensers or heat exchangers, this 20-page Bridgeport book is must reading. It tells how to lick problems involving two corrosive media... by using bi-metal Duplex Tubes ...each metal surface designed to resist corrosion from the media to which it is exposed.

Each industry has its own corrosion problems, and this fact-packed book illustrates ways to solve many of them. For your personal copy, just write, on your company letterhead, to the Bridgeport Brass Company, Bridgeport 2, Connecticut. Please address Dept. 5304.

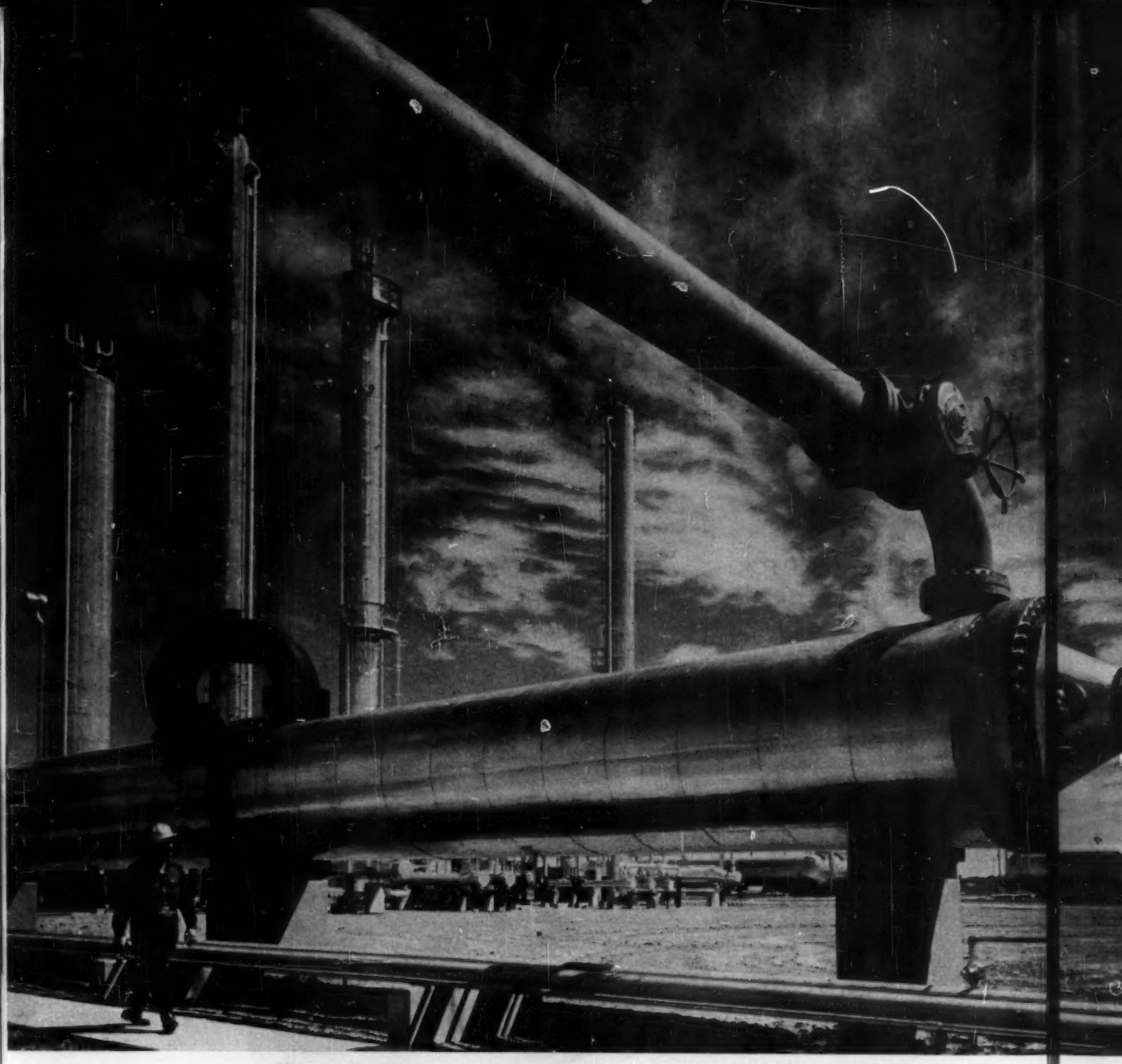
Bridgeport Brass Co.

BRIDGEPORT BRASS COMPANY

Bridgeport 2, Connecticut • Sales Offices in Principal Cities

Specialists in Metals from Aluminum to Zirconium

For more data on advertised products, use Readers' Service Cards, last page.



The extraction plant of Runnels Gas Products Corporation at Eunice, La., processes more than 300 mmcf. of pipeline gas daily to yield 5,000 barrels of liquid hydrocarbons (all the natural gasoline and butanes, 96% of the propane and 35% of the ethane.) Fuel-gas consumption is less than 3%. Absorption takes place at -40°F.

What's new in gas processing?

Anyone contemplating construction of a natural-gas processing plant, whether its purpose is treating, extraction or a combination of both, must first solve a puzzle with three complex variables. The efficiency and profitability of the plant depend on how well the puzzle is solved.

The first variable is, of course, the volume and composition of the inlet gas stream. The second is the market, if any, for extracted products, and the third is the legal and technical requirements for residue gas.

Major shifts in these variables make it profitable today to design gas-processing plants that differ radically from those built only a few years ago, and to locate them much farther away from the gas fields.

When you consider expansion...
the most important investment you can make
is in the creative ability of men.

FLUOR

Engineers and Constructors

For example, it is now advantageous to build large, highly efficient extraction plants to handle great volumes of lean Louisiana gas. Such plants serve the tremendously expanded LPG market for butanes and propane, and the petrochemical market for both of these, plus ethane. Because of the volume of gas, and the degree of extraction desired, a combination of extreme cold and light-oil absorption is the most efficient way to get the marketable hydrocarbons out. Refrigeration costs are more than offset by the use of smaller quantities of lighter oil, with consequent savings in pumping and stripping capacity.

As the natural-gas industry mushrooms, the trend is toward large plants, not only for hydrocarbon extraction but for sour-gas treating as well. And as the plants grow bigger, new levels of efficiency can be reached through methods that were impractical in smaller installations.

The development of new techniques for large-volume gas processing has been a Fluor contribution to the industry. The combined experience of the gas specialists in Fluor's Los Angeles and Midcontinent divisions represents a pool of advanced know-how that is unequaled anywhere.

The Fluor brochure, "Opportunities in Gas Processing," will be helpful to anyone planning construction of a processing facility. Write to Dept. 46, The Fluor Corporation, Ltd., 2500 South Atlantic Boulevard, Los Angeles 22, California.

WE'LL MEET YOUR METAL CHLORIDE NEEDS FROM A TO Z

Do you need chlorides as catalysts or co-catalysts to make butyl rubber, plastic and elastomeric polyolefins, styrene, ethyl chloride, dyes, petroleum products and other products of Friedel-Crafts reactions?...or as sources of pure metal, high-energy fuels or chemical intermediates?

We have the chloride intermediates or catalysts.

We know how to produce them in grades which you can use with maximum economy and efficiency.

We can be of service to you...and be glad to!

Write for literature on Metal Chlorides and Metallo-organics.

Stauffer

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, New York
Prudential Plaza, Chicago 1, Illinois
824 Wilshire Boulevard, Los Angeles 17, California
636 California Street, San Francisco 8, California
P. O. Box 9716, Houston 15, Texas

ANDERSON CHEMICAL COMPANY DIVISION, Weston, Mich.

METAL CHLORIDE COMPOUNDS

Aluminum Chloride
Sealdbins from Baton Rouge, La.; tank trucks from Elkton, Md.; 5-, 10-, and 55-gallon drums from Houston, Tex., Baton Rouge and Elkton.

Antimony Trichloride
Flake or solid in drums from Niagara Falls, N.Y.

Antimony Pentachloride
Liquid, in 10-gallon drums from Niagara Falls, N.Y.

Boron Trichloride
Tank cars from Niagara Falls, N.Y.

Chromium Trichloride
In developmental quantities from Richmond, Cal.

Columbium Pentachloride
Commercial quantities from Richmond, Cal.

Silicon Tetrachloride
Drums, tank cars and tank trucks from Niagara Falls, N.Y.

Tantalum Pentachloride
Commercial quantities from Richmond, Cal.

Titanium Tetrachloride
Drums and tank cars from Niagara Falls, N.Y.

Titanium Trichloride (two types)
Stauffer is the only commercial producer. Drums from Richmond, Cal., and Weston, Mich.

Vanadium Oxytrichloride
In commercial quantities from Anderson Chemical Division, Weston, Mich.

Vanadium Tetrachloride
In developmental quantities from Anderson Chemical Division, Weston, Mich.

Vanadium Trichloride
In developmental quantities from Anderson Chemical Division, Weston, Mich.

Zirconium Tetrachloride
In drums or Sealdbins from Niagara Falls, N.Y.

And more than 300 Organic, Inorganic and Metallo-Organic compounds based on Aluminum, Antimony, Boron, Cadmium, Germanium, Iron, Lithium, Magnesium, Mercury, Phosphorus, Selenium, Rare Earths, Silicon, Sodium, Tin, Titanium, Vanadium and Zirconium from Anderson Chemical Division, Weston, Mich.

For more data on advertised products, use Readers' Service Cards, last page.

NEW NEW NEW NEW

TYPE T

The economy cable, Type T Dekoron Multicouple Cable consists of insulated, numbered and twisted wires covered with 90% closed No. 30 cotton braid and outer sheath of .050" thick 105°C PVC. Moisture and chemically resistant; approved for direct burial. Can be installed without conduit, or with smaller conduit when necessary.

TYPE A

Same construction as Type T, above, except has outer covering of modified square lock galvanized steel armor overall which shields cable, serves as conduit and provides crush resistance with great flexibility.

TYPE AT

Type AT Dekoron Multicouple Cables incorporate all advantages of Types A and T. Consists of armored Type A sheathed with .050" thick 105°C PVC. Moisture, chemical, and high crush resistance. Approved for direct burial or installation without conduit in open racks.

DEKORON®

MULTICOUPLE EXTENSION WIRE

Dekoron multiple pair harness of thermocouple extension wire is available *now* in three constructions, each in either Iron-Constantan or Chrome-Alumel. All are guaranteed to *meet or exceed ISA specs* for standard grade extension wire.

And — equally important — all are designed to drastically reduce thermocouple extension wire costs. Dekoron Multicouple Extension Wire reduces installation and maintenance time . . . often cuts initial material costs . . . *always lowers installed costs.*

A-114A

Dekoron® *products* QUALITY • RESEARCH • SERVICE

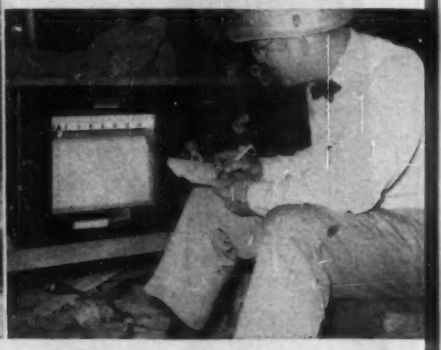
SAMUEL MOORE & COMPANY

DEKORON PRODUCTS DIVISION • MANTUA, OHIO

Portable X-ray unit used by CB&I to inspect welded seams on field erected work.

Two 31-foot diameter Hortonspheres® designed for 250 lbs. per square inch pressure, store propane at Company's Torrance, California refinery.

Multiple point potentiometer is used to electronically record the temperatures on various points of the structure during stress relieving.



Hard Working HORTONSPHERES® stress relieved and X-rayed in the field

To meet a specific set of customer requirements, these high pressure, 2,778-barrel capacity Hortonspheres were fabricated at CB&I's Salt Lake City plant and then stress relieved and X-ray inspected *after* they were erected for General Petroleum Corporation's refinery.

Field X-ray and stress relieving facilities are typical of the many highly specialized metallurgical techniques and equipment which CB&I has pioneered and put to work on structures that *work* rather than merely *serve.*

Such facilities point up the many "extras" you get when you specify CB&I . . . the engineering service and attention to metallurgical details that mean a *lot* in today's complex refining operations.

Write your nearest CB&I office for the brochure: *The Evolution of the Oil Storage Tank.*

CB&I

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Kansas City (Mo.)
New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • South Pasadena • Tulsa
Plants in Birmingham • Chicago • Salt Lake City • Greenville, Pa. • New Castle, Delaware

SUBSIDIARIES:
Horton Steel Works Limited, Toronto; Chicago Bridge & Iron Company Ltd., Caracas; Chicago Bridge Limited, London; Chicago Bridge Construcoes Ltda., Rio de Janeiro

REPRESENTATIVES AND LICENSEES:
Australia, Cuba, England, France, Germany, Italy, Japan, Netherlands, Scotland

for integrity in . . .

Engineering . . .
Fabrication . . .
Erection

Welded steel structures serve better and last longer with CB&I coordinated services.

PB1C9

SPIRAL CONDENSERS ON TOP

Our new Series "G" condensers are designed for installation as the top section of a column or for direct connection to the vapor outlet nozzle of a vessel.

Economy is obvious in the elimination of elaborate supporting structures, large diameter vapor lines and other auxiliaries essential to conventional designs.

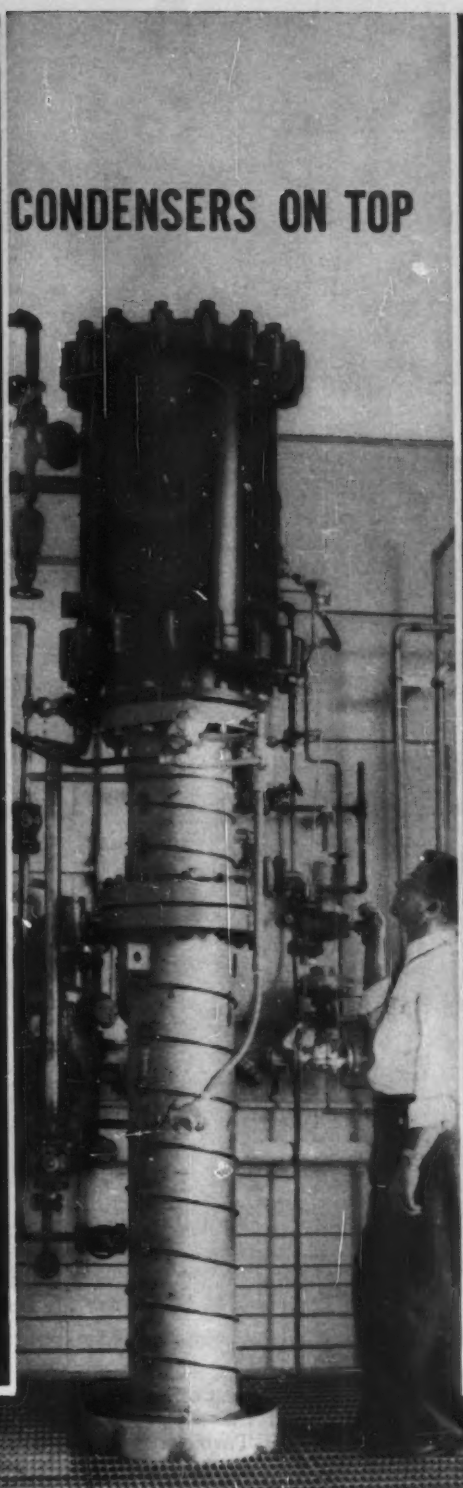
None of the exclusive features of the Spiral condenser have been sacrificed for this direct mounting arrangement. The vapor path can be full counter current spiral flow, combined cross flow-spiral flow or full cross flow. Any combination for maximum or minimum cooling of condensate and noncondensables can be obtained in the in-built after-cooling zone.

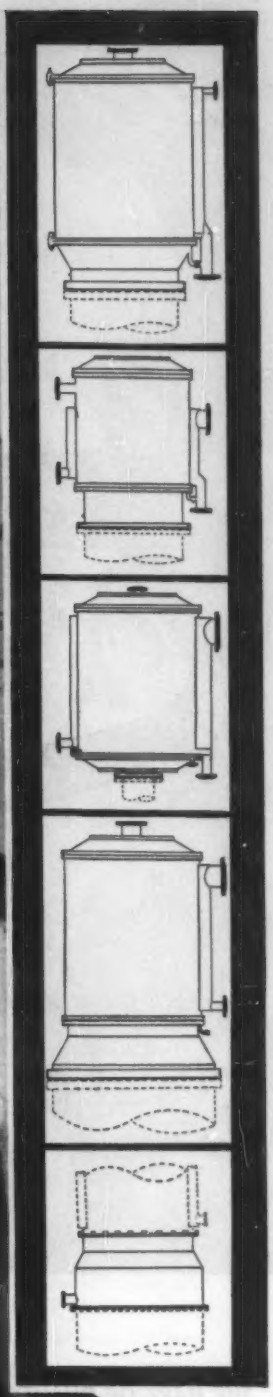
The Spiral condenser is unequaled for stripping out soluble gases. The rapid and complete separation of condensate from fixed gases prevents partial re-absorption, and separate outlets are provided for the condensate and the noncondensables.

The Spiral is furnished for either total, partial, reflux, vent or knock-down condensing services in sizes from 15 sq. ft. to 1600 sq. ft. and for design pressures up to 150 p.s.i.g. Large volume condensate retention capacity can be incorporated when desired.

Spirals are fabricated in any material that can be cold formed and welded to ASME Code requirements.

Write for full particulars.



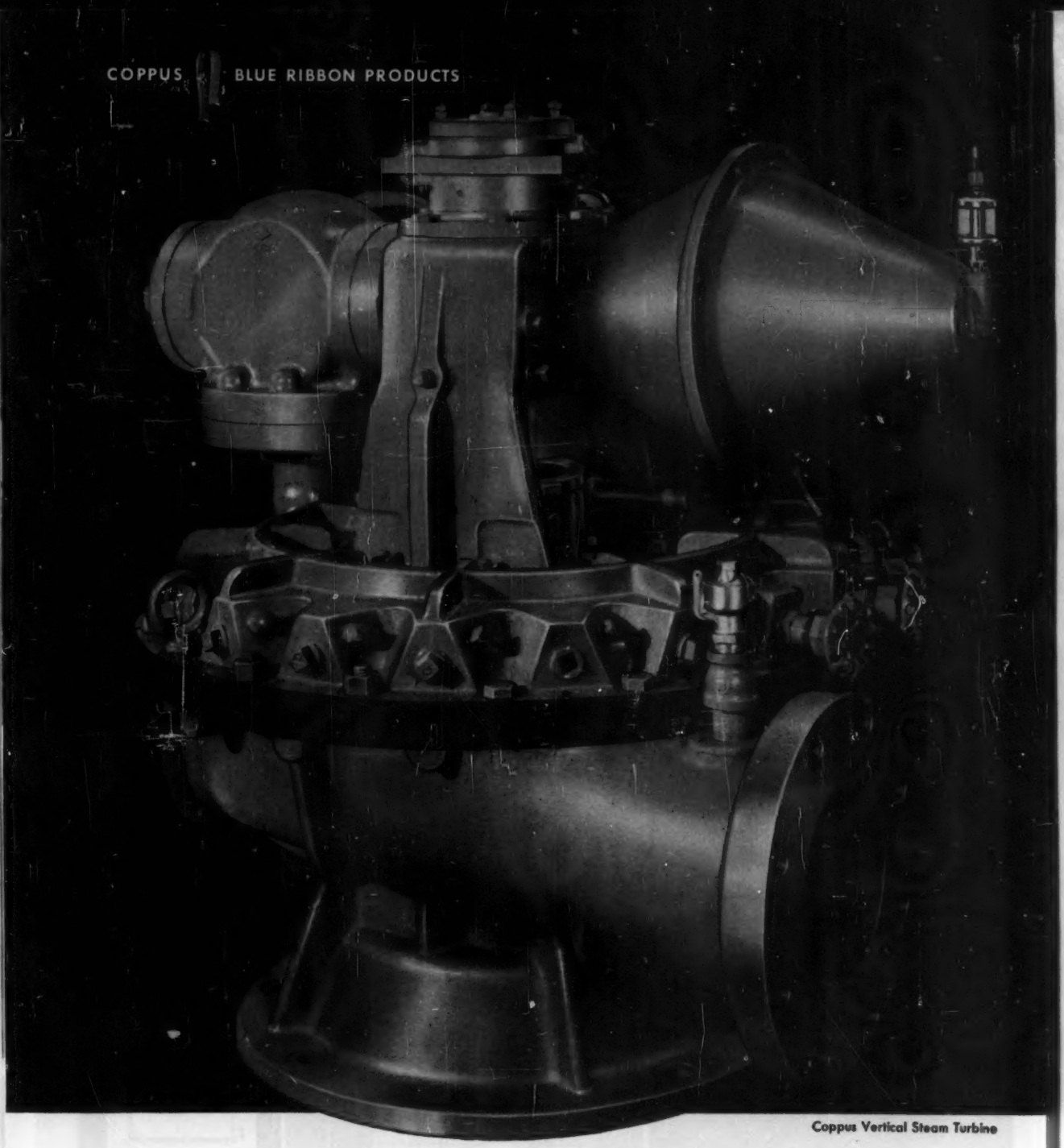


ahrco

AMERICAN HEAT RECLAIMING CORPORATION
1270 Sixth Avenue, New York, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

COPPUS BLUE RIBBON PRODUCTS



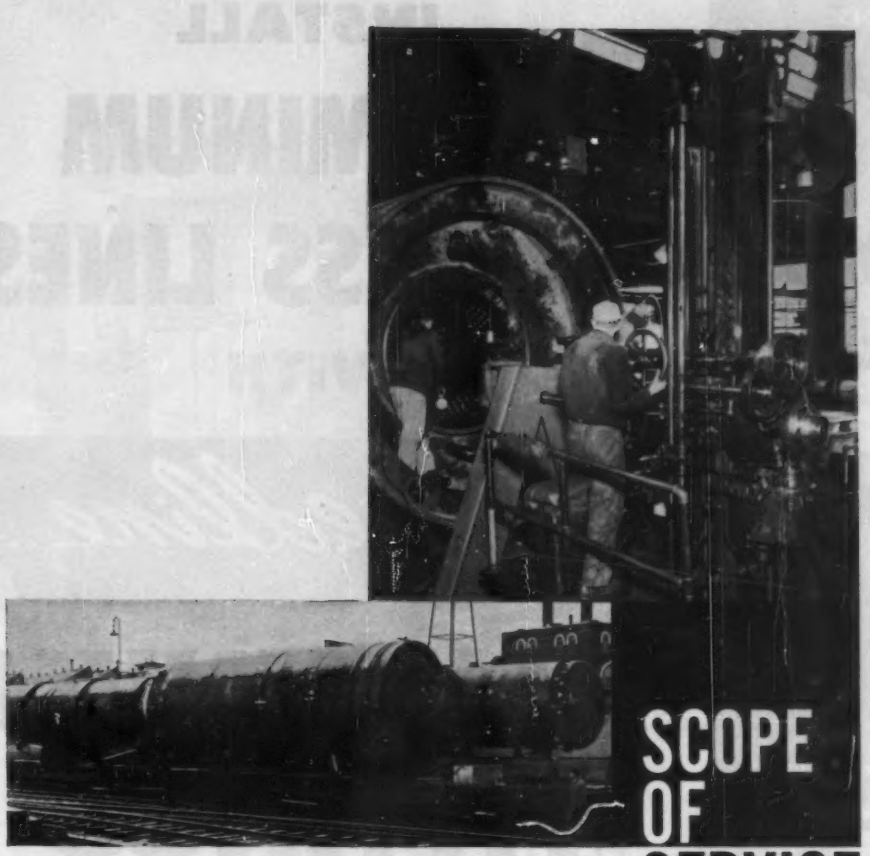
Coppus Vertical Steam Turbine

THE MARK OF QUALITY — There's no better test of a turbine's quality than performance. And the new, ruggedly designed, power-packed Coppus Turbines pass all performance tests with top honors! Small wonder. Coppus quality is literally designed and built into them. Their super stamina is the end-product of painstaking craftsmanship, finest materials and methods, thorough testing and control. Each truly deserves its Blue Ribbon . . . assurance of *complete* reliability.

Typical Coppus Blue Ribbon features are: *totally enclosed governor . . . totally enclosed and independently operated safety trip . . . easily replaceable packing and bearings . . . multiple steam nozzle control . . . brake rim for added safety . . . wide bucket "L" type wheel (optional) for minimum water rate.* You get higher efficiency operation . . . less down time . . . lower maintenance costs.

Coppus Turbines are built to customers' specifications, including API and NEMA standards. Send for Catalog 200. Get complete details on Coppus Turbines. Sizes from 1 HP to 250 HP. Write COPPUS ENGINEERING CORPORATION, 419 Park Avenue, Worcester, Mass. Sales Offices in *Thomas' Register*.

COPPUS
STEAM TURBINES



SCOPE OF SERVICE

For 43 years the facilities of this large and well-equipped plant for ship and engine building have been employed in building special equipment for oil refineries and chemical plants.

This equipment varies from small tanks to large Fractionating Towers, Stills, Pressure Vessels, Special Machinery, Plate Work, etc. Carbon or alloy steel-annealed and X-rayed.

THE PLANT—Our plant consists of such a variety of shops and machinery that it is unnecessary to sublet when building the type of equipment here listed. The plant consists of:

Boiler and Tank Shops

Steel Fabricating Shops	Machine Shops
Blacksmith Shop	Pipe Shop
Anglesmith Shop	Electric Welding
Coppersmith Shop	Stainless Shop

RAIL OR WATER SHIPMENT—Our plant, located on the Delaware River with piers and deep water to care for sea-going ships, has railroad connections to all points.

We have adequate facilities to handle our work in all its phases and do not have to sublet.

Further information, estimates or proposals on request.

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • SINCE 1916 • CHESTER, PA.

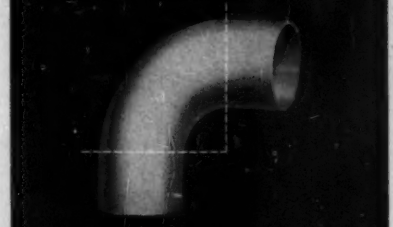
For more data on advertised products, use Readers' Service Cards, last page.

SERRATED FLANGES

Flat Face—Standard 150 #. Drilling

Unique design eliminates welding. Assemble with fast, easy "expanding" operation that insures tight, leakproof joints.

EXTRA FITTING LENGTH



Extra length on every end of every fitting . . . facilitates flanging or welding.

ALIGNING CONNECTORS

Simplifies socket joining of pipe and fittings. Insures positive pipe alignment . . . speeds welding.

INSTALL ALUMINUM PROCESS LINES WITH Speedline® ALUMINUM FITTINGS

for approximately the same installed cost as Schedule 40 Carbon Steel Lines!

get

- **GREATER CORROSION RESISTANCE**
- **A MAINTENANCE-FREE SYSTEM**

DESIGNED FOR USE WITH SCHEDULES 10 AND 40 ALUMINUM PIPE

Manufactured by the Originators of Speedline Stainless Steel Fittings with the Exclusive "Tangential Feature"

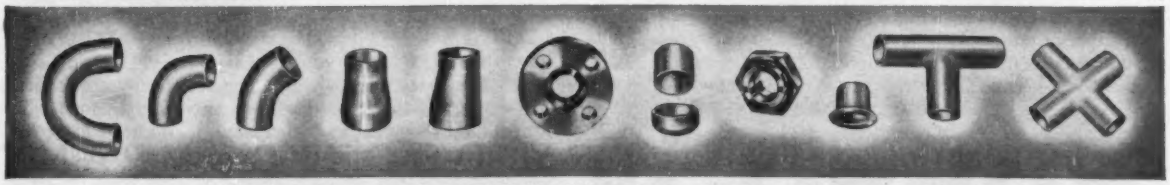
Speedline®

© REG. T.M. OF HORACE T. POTTS COMPANY

CORROSION-RESISTANT FITTINGS

ALSO HASTELLOY, TITANIUM AND OTHER ALLOYS ON APPLICATION

913



A Product of HORACE T. POTTS COMPANY • 566 E. Erie Avenue • Phila. (34), Pa.

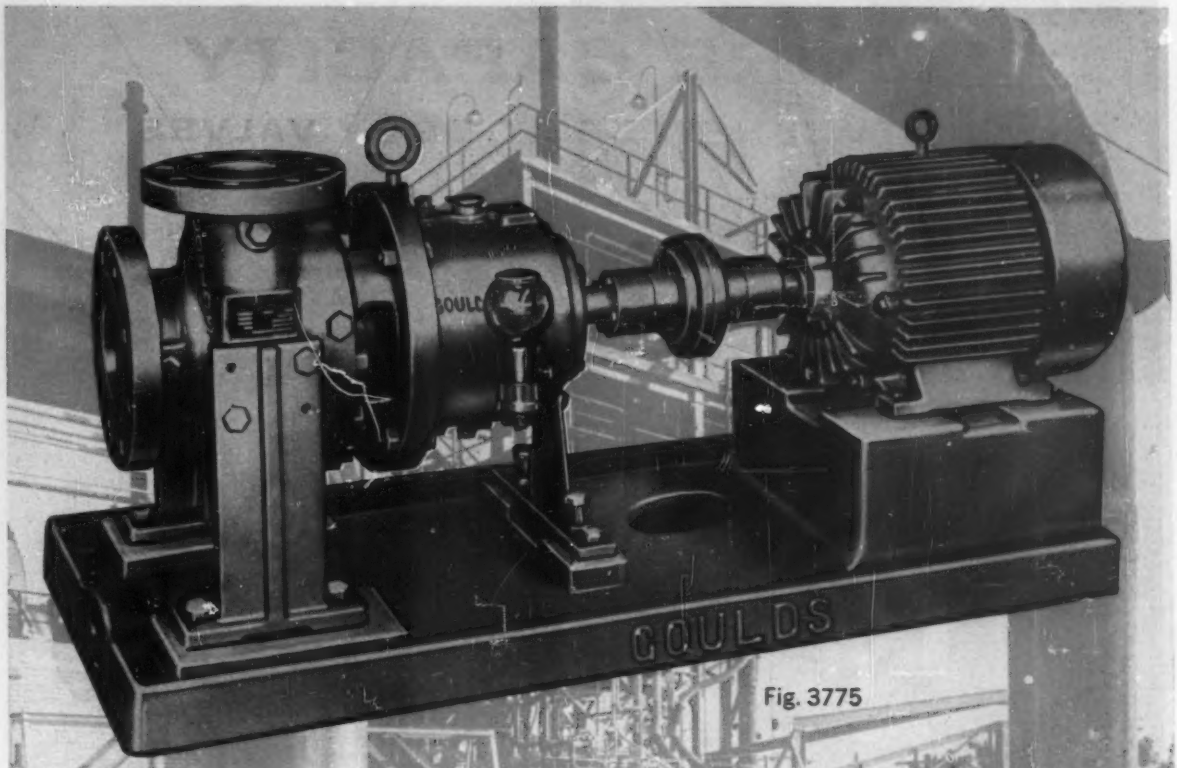


Fig. 3775

NEW PROCESS PUMP FROM GOULDS!

See all the advantages of practical design:

(1) Back pull-out design for ease of seal replacement and maintenance. (2) All 11 sizes are built on the same bearing frame, assuring the economy of maximum standardization. (3) All pumps are fitted with renewable impeller wearing rings. (4) Built in accordance with API 610 specifications. (5) Water-cooled seal chamber and bearing housing for both internal and external seal flushing. (6) All mechanical seal designs available. (8) Horizontal centerline mount, vertically split case. (9) 300-lb. raised face flanges.

Write and ask us for Bulletin 724.1, Goulds Pumps, Inc., Dept. PR-79, Seneca Falls, N. Y.

GOULDS PUMPS

SISTER PUMP . . . Goulds Fig. 3675, a unique close-coupled model, installs in any position.

For more data on advertised products, use Readers' Service Cards, last page.

MORE CAPACITY

TWO NEW SPLIT-BODY VALVES

"S" DESIGN

"Y" DESIGN

BEST BY PRESENT AND FUTURE STANDARDS!

The advanced new "Y" design incorporates I.S.A. standard face-to-face* dimensions, "S" valve travels and actuators. But it sets **new standards** for CV per nominal pipe size and for mechanical characteristics of fluid control. Straight-through flow eliminates hold-up and Cv's are **phenomenal** in every size.

Nominal Sizes: ½" to 10"

Body Configurations: "Y" and "YL" (45° angle)

Body Rating: 600 lb. ASA to 2500 lb. ASA

Connections: 150 to 2500 lb. ASA Flanged (Integral Flanges.) Screwed or welding ends.

***Face-to-Face:** I.S.A. Std. thru 4" size. Also available in non-standard dimensions.

Materials: Cast Steel, Stainless Steel, Cast Iron, Nodular Iron, or any castable alloy.

You can reduce costs with one of these new Split-Body designs. It's sure worth checking with the Hammel-Dahl Representative in your area. Call today.

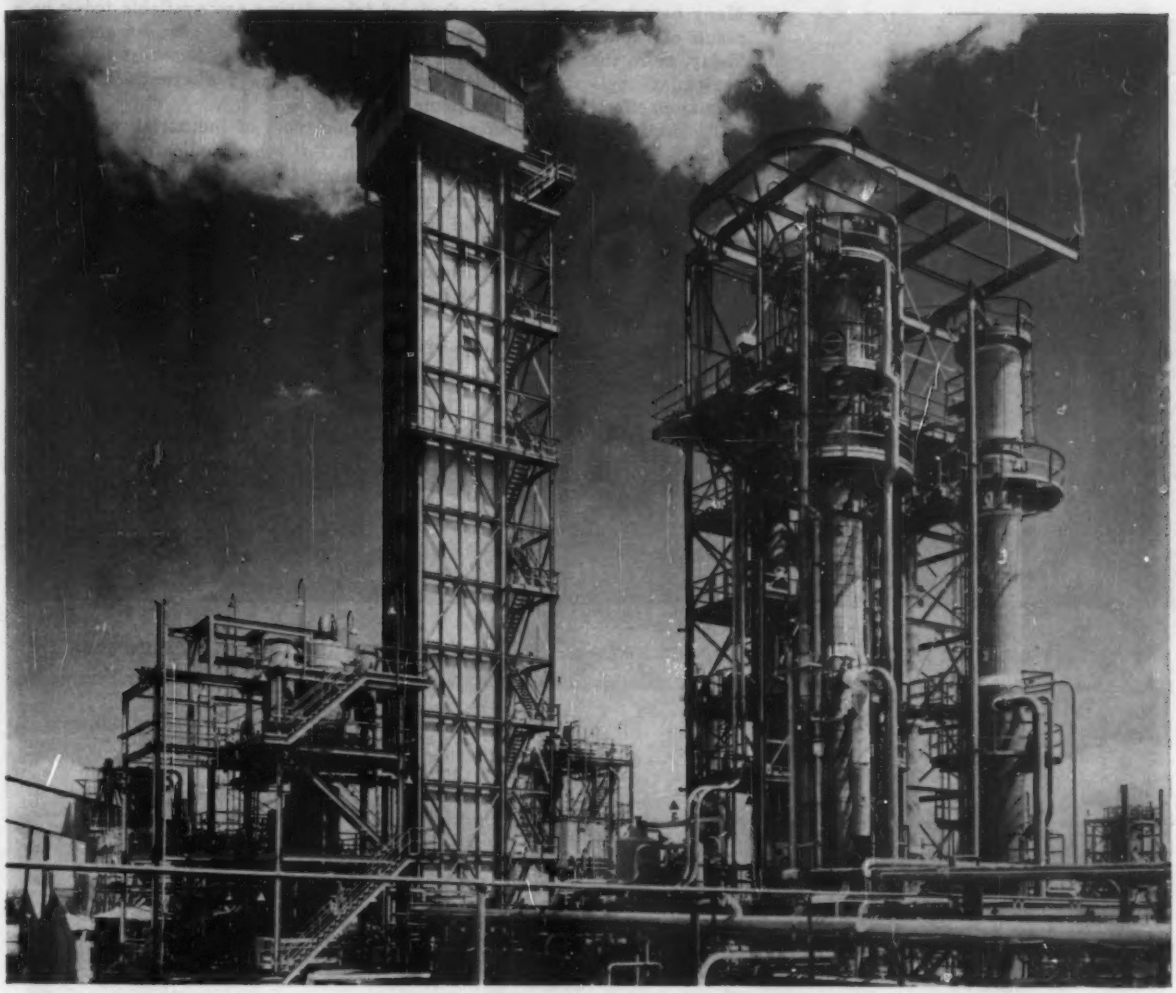
Manufacturers of Control Valves and Allied Equipment

HAMMEL-DAHL DIVISION

GENERAL CONTROLS

Warwick Industrial Park, Warwick, Rhode Island

Representatives in Principal Cities of United States, Canada and Europe



A precedent-setting new concept in engineering service

The Pechiney-Grace Urea Process by Foster Wheeler

Now Pechiney's basic urea synthesis, Grace's operating experience and Foster Wheeler's engineering design and construction experience are available as a totally new packaged service to licensees.

It's a unique package, giving you:

- a total recycle process covered by one licensing agreement, from feed end through finishing operations, yielding urea of the highest purity.
- the benefits of experience gained by W. R. Grace in modifying and improving the original Pechiney Process and operating a full-scale plant for four years.
- Foster Wheeler's experience in originally bringing the Pechiney Process from pilot plant to full-scale commercial operation, and working with Grace engineers on subsequent improvements which created the Pechiney-Grace Process.

The new license package also makes available for the first time a new ammonia recovery system—currently saving 10-15 tons a day for Grace, and a highly efficient purification system. For information write to: *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.*

FOSTER WHEELER

NEW YORK LONDON PARIS ST. CATHARINES, ONT.

For more data on advertised products, use Readers' Service Cards, last page.

Many new techniques and methods of telemetering are available today as a result of rapid advances in the science of data processing and transmission. Today, more than ever, selection of the telemetering system best suited to a particular application requires careful study of many alternatives to insure maximum effectiveness at minimum cost.

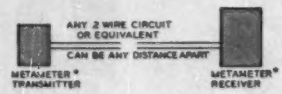
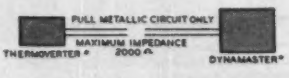
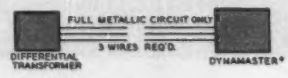
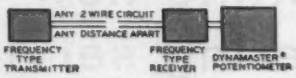
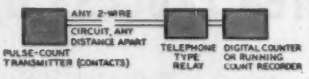
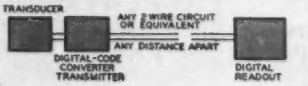
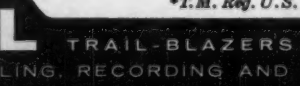
The Bristol Company offers *all* the major types of industrial telemetering systems, as outlined in the table herewith. For some applications, of course, certain features of one system may be combined with another, allowing great flexibility in tailoring a system to your application.

The complete line of Bristol industrial telemetering instruments embodies over 45 years' experience in this field. Bristol engineers are always ready to recommend telemetering instruments to solve your particular problems or to work closely with your own engineers in the design of a complete telemetering system to your requirements.

For further information, write: The Bristol Company, 111 Bristol Road, Waterbury 20, Connecticut.

TIPS ON INDUSTRIAL TELEMETERING

for pipe lines, utilities, and process industries

TYPE	OFFERED BY BRISTOL	SIMPLIFIED BLOCK DIAGRAM	ADVANTAGES AND LIMITATIONS	MAJOR USES
IMPULSE DURATION	Metameter®		Simple electro-mechanical device. Will transmit over wire circuit, carrier or microwave links. Offered in 60, 15, 5 or 2 second impulse cycles.	For analog transmission of all measurands.
VOLTAGE	Thermoverters® & Dynamaster.® D-C Transmission		Instantaneous transmission. Limited to full metallic circuits of 2000 ohms (2 wires) free of parisitic currents.	For analog transmission of electrical quantities.
	Differential Transformer Transmitter & Dynamaster. A-C Transmission		Instantaneous transmission. Limited to full metallic circuits. (3 wire.) Can operate into electronic control directly.	For analog transmission of mechanical measurands.
FREQUENCY	Frequency Type Transmitter & Receiver with or without Audio Tone. (RFL) Model with Dynamaster End Device		Practically continuous. For millivolt inputs or measurand to millivolt pick-ups. Will operate over wire circuits, carrier or microwave radio links.	Primarily for transmission of electrical measurands but may be adapted to non-electrical quantities where high speed transmission desired.
PULSE COUNT	Transmitter — Contact Making Device. Receiver — Relay Operated Magnetic Counter or Running Count Recorder		Simple. Will transmit over wire circuit, carrier or microwave link.	Primarily for total flow transmission. Not used for instantaneous flow.
POSITION	Dynamaster Resistance Thermometer System		Instantaneous Transmission. Requires 3 wire metallic circuit not exceeding 1500 feet.	Temperature measurements.
PNEUMATIC	Metagraphic System. Metavane® System		Limited to 1000 feet of ⅛" tubing. Can operate into pneumatic control directly.	For non-electrical quantities where pneumatic transmission desired.
DIGITAL	Bristol Servo Transducer with Westinghouse, G. E., or Union Switch & Signal Pulse Code System		For transmission over wire circuits, carrier or microwave.	For digital transmission of all measurands, especially where pulse code supervisory control is available. Direct print-out of readings.

®T.M. Reg. U.S. Pat. Off. **Write for technical information**

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Klinger PISTON TYPE VALVES

THE photograph shows a small part of the Fermentation plant at the Beecham Research Laboratories at Betchworth, England, where microbial substances are produced. All the valves visible in the picture and throughout the plant are Klinger Piston Valves. Klinger Sleeve-packed Cocks are also installed. The fluids controlled by valves include steam, hot and cold water, brine and compressed air.

THE KLINGER CORPORATION OF AMERICA, 95 RIVER STREET, HOBOKEN, NEW JERSEY.
Telephone: OLDFIELD 6-1300.

Manufacturing Licensees for Canada

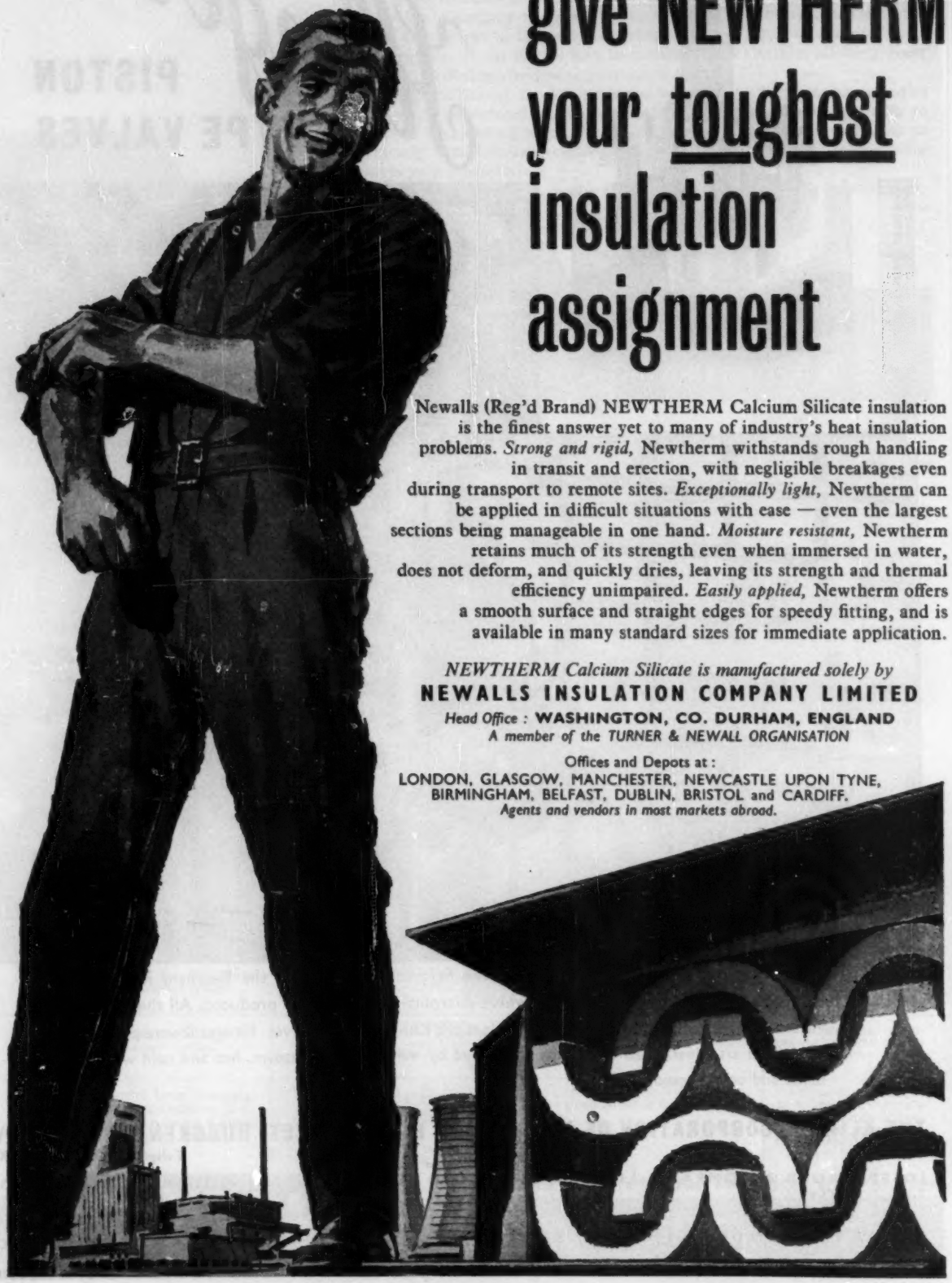
JOSEPH ROBB & COMPANY LIMITED, 5575, COTE ST. PAUL ROAD, MONTREAL, 20, CANADA
Telephone: GLENVIEW 9151
Branches at: SYDNEY, HALIFAX, OTTAWA, TORONTO, HAMILTON, WINNIPEG, EDMONTON, VANCOUVER, QUEBEC CITY

RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND.

GA43/58/V

For more data on advertised products, use Readers' Service Cards, last page.

give NEWTHERM your toughest insulation assignment



Newalls (Reg'd Brand) NEWTHERM Calcium Silicate insulation is the finest answer yet to many of industry's heat insulation problems. *Strong and rigid,* Newtherm withstands rough handling in transit and erection, with negligible breakages even during transport to remote sites. *Exceptionally light,* Newtherm can be applied in difficult situations with ease — even the largest sections being manageable in one hand. *Moisture resistant,* Newtherm retains much of its strength even when immersed in water, does not deform, and quickly dries, leaving its strength and thermal efficiency unimpaired. *Easily applied,* Newtherm offers a smooth surface and straight edges for speedy fitting, and is available in many standard sizes for immediate application.

NEWTHERM Calcium Silicate is manufactured solely by

NEWALLS INSULATION COMPANY LIMITED

Head Office : **WASHINGTON, CO. DURHAM, ENGLAND**

A member of the TURNER & NEWALL ORGANISATION

Offices and Depots at :
LONDON, GLASGOW, MANCHESTER, NEWCASTLE UPON TYNE, BIRMINGHAM, BELFAST, DUBLIN, BRISTOL and CARDIFF.
Agents and vendors in most markets abroad.

M·A·N

The following are some of the products we design and manufacture:

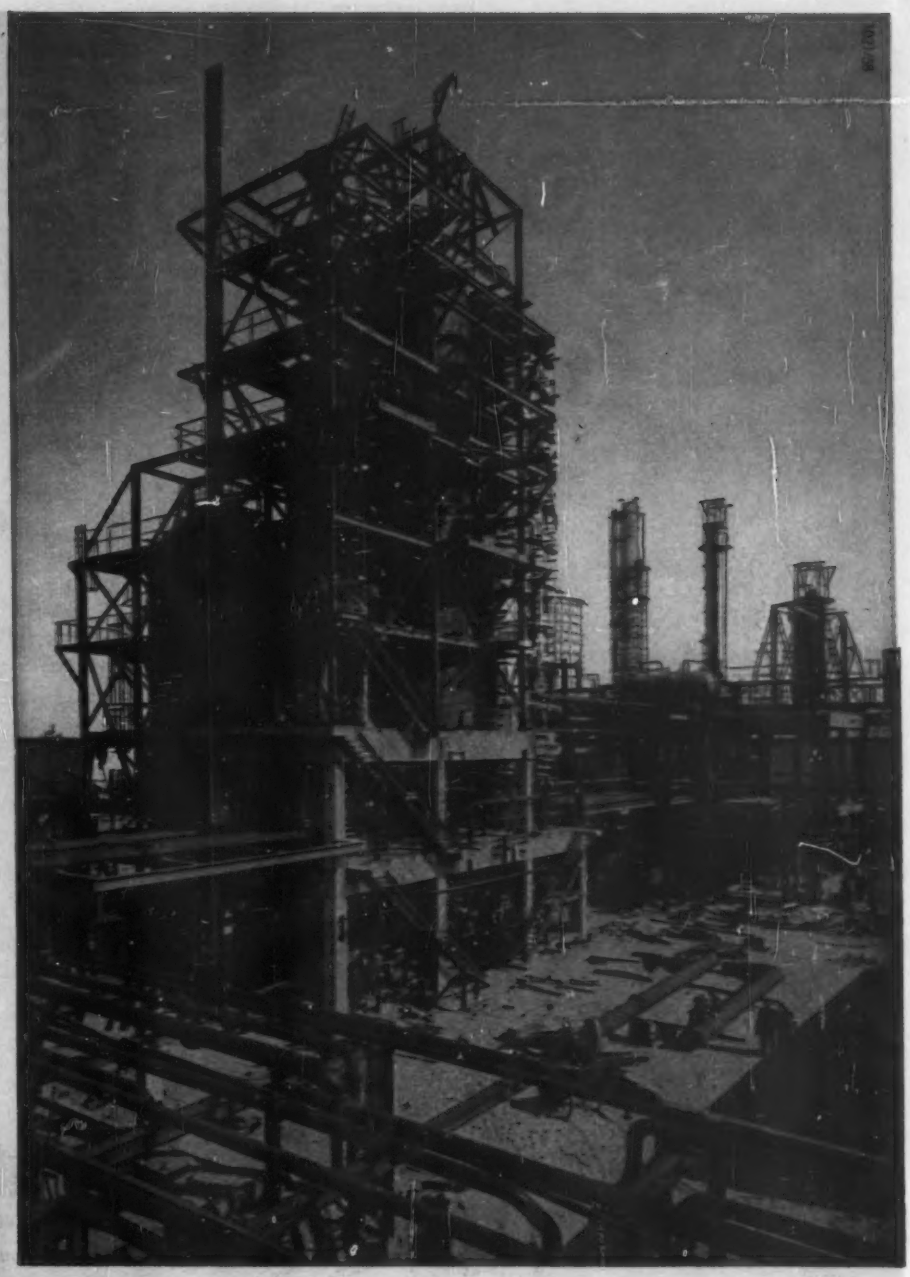
STEAM BOILERS

STEAM POWER STATIONS

TURBINES

DIESEL ENGINES

GAS ENGINES



Responsible for process and engineering was: N. V. de Bataafsche Petroleum Mij., The Hague and Lummus Nederland N. V., The Hague. Responsible for purchasing was: Edeleanu GmbH, Frankfurt.

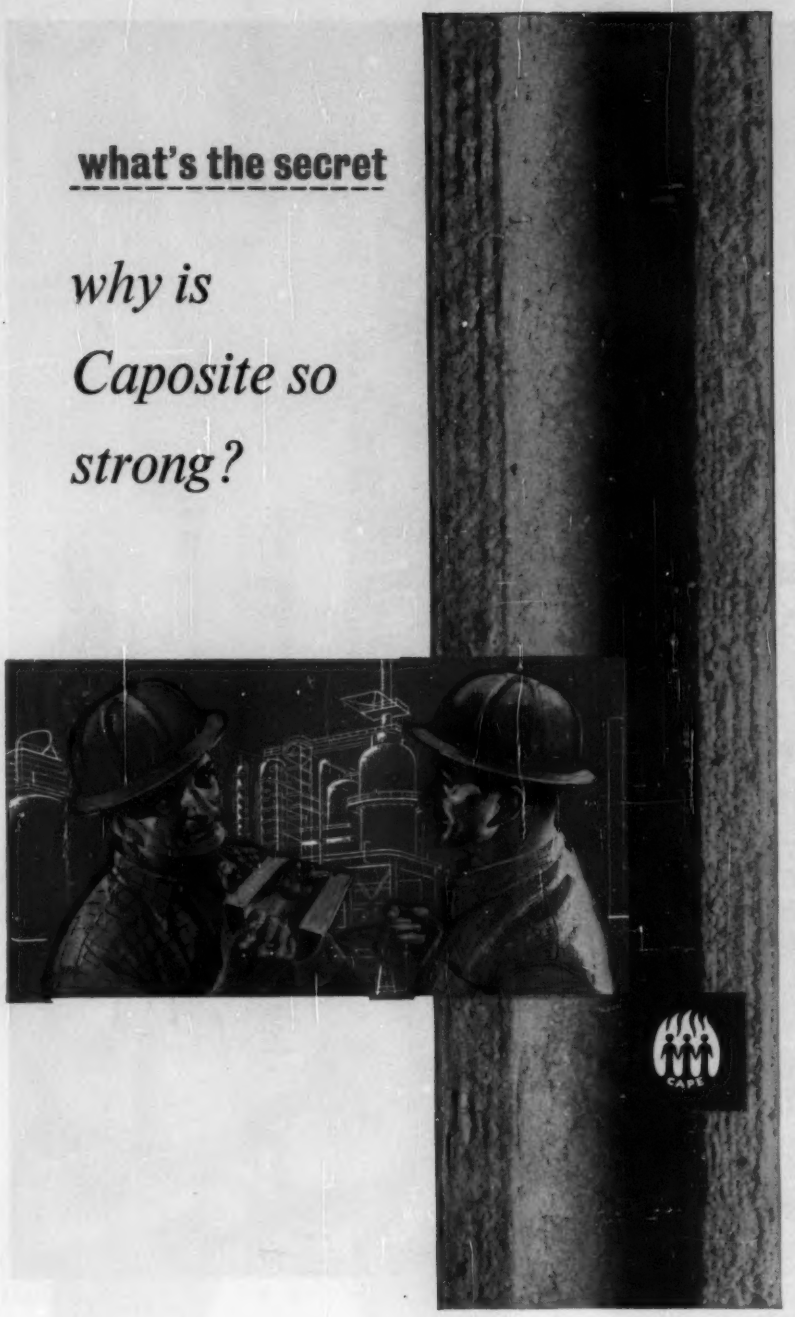
We recently supplied and installed all apparatuses and structural steelwork required for the

CAT CRACKER AND GAS RECOVERY PLANT
DEUTSCHE SHELL AG
HOHE SCHAAR REFINERY, HAMBURG

MASCHINENFABRIK AUGSBURG-NÜRNBERG AG · GUSTAVSBURG WORKS
GUSTAVSBURG/HESSEN (GERMANY) · REPRESENTATIVES IN ALL COUNTRIES

what's the secret

why is Caposite so strong?



It's no secret why CAPOSITE insulation is so strong and stands up to such rough usage. These pipe sections and blocks are made wholly of Amosite asbestos and the long fibres of this particular kind of asbestos give CAPOSITE its strength and resilience as well as its high insulating value. This exceptional strength leads to many other features besides long life; it means that larger sizes of pipe sections and blocks are possible, making application easier and faster. Less care is needed in handling the material. Unlike other moulded insulation, CAPOSITE, because of its strength, can be shipped to refineries anywhere in the world *in cardboard cartons*, showing big savings in freight and storage costs.

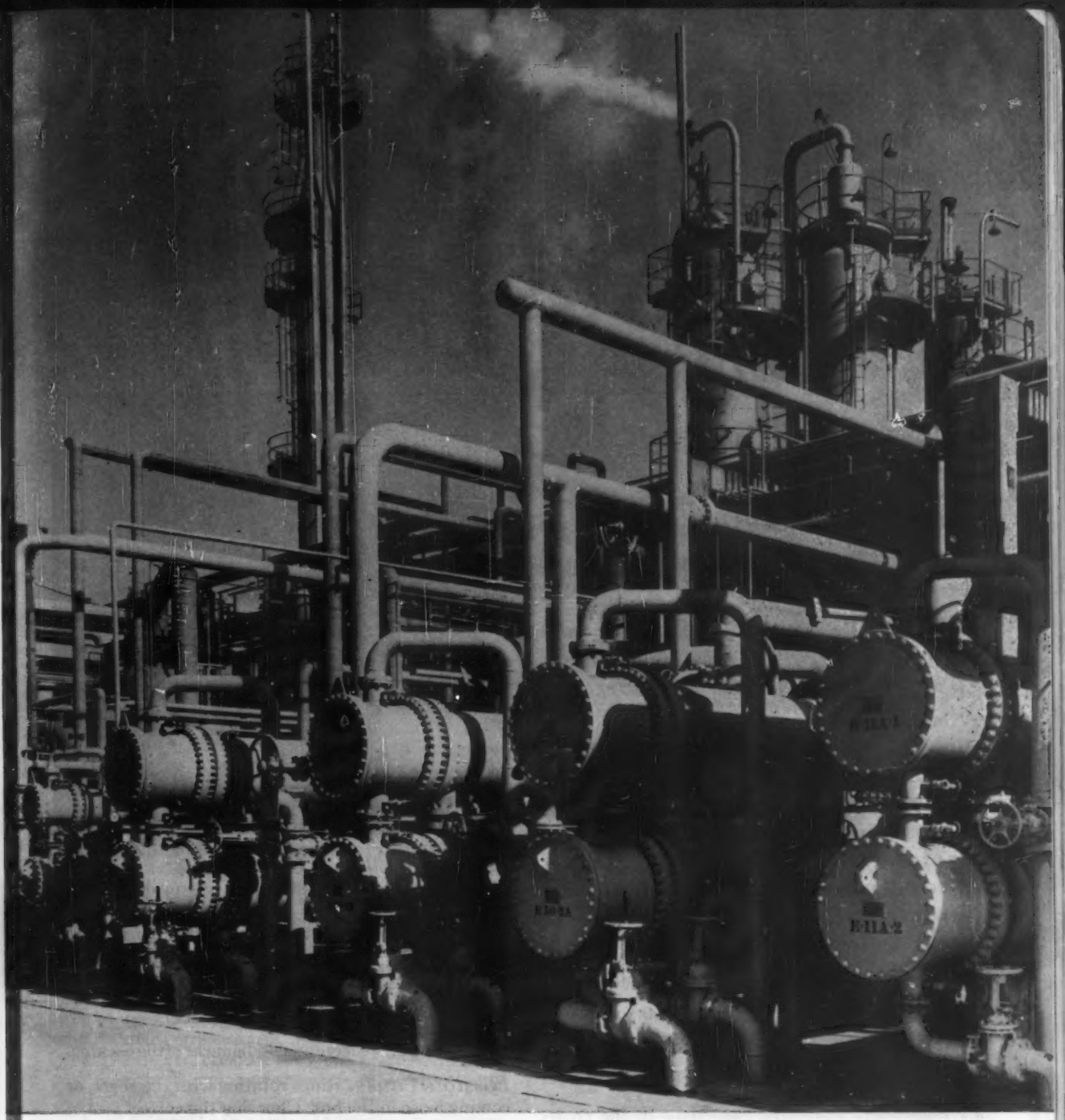
CAPOSITE Regd.

ASBESTOS INSULATION

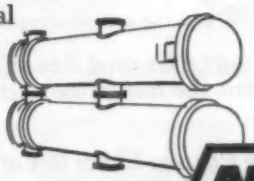
THE CAPE ASBESTOS COMPANY LIMITED, 114 & 116 PARK STREET, LONDON W1 Tel: Grosvenor 6022 Cables: Incorrupt London

Enquiries in Canada to: Cape Asbestos (Canada) Limited, 200 Bloor Street East, Toronto, Ontario
U.S.A.: North American Asbestos Corporation, Board of Trade Building, Chicago 4, Illinois

YA 10643



ON STREAM, ON TIME . . . these Kellogg heat exchangers, fabricated in the company's Jersey City shops, are just a few of the thousands Kellogg has put into service for leading petroleum refiners and chemical companies throughout the world. Stacked-unit fabrication techniques in the plant assure alignment and cut erection time in the field. For prompt deliveries plus design and engineering excellence at optimum cost, call Kellogg's Fabricated Products Sales Division.



THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17, N.Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Company Limited, Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

M W KELLOGG

News and Notes on...

Good Packing Practice

JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

Subject of the month: Trouble-shooting Packing Problems

Question:

How can you pinpoint the cause of a premature failure?

If you carefully examine used packing, a correct interpretation of the damage will often suggest exactly what caused a premature failure.

Generally speaking, the reasons fall into three areas: (a) the wrong size or style packing was selected for the particular service conditions, (b) the packing was not properly installed, or (c) the equipment requires maintenance. And any of these three conditions can not only result in premature packing failure . . . but can lead to other headaches resulting from poor performance of equipment.

Let us review some of the most common types of packing failures and their causes . . . easy to recognize through a careful inspection of the damaged packing.

1. ***Damage:*** Excessive reductions in the cross-section of the packing.

Possible cause: Bearing worn, or other shaft misalignment result in eccentric movement such as shaft "whip."

2. ***Damage:*** Wearing face of the rings dried and charred, but the rest of the packing is still in good condition.

Possible Cause: Either lack of proper lubrication, or the packing was not designed to withstand speed of movement involved, or the temperature range of service encountered.

J-M #7 Centripac® Packing shown here is designed specifically for single-stage centrifugal pumps in the process industries. Speeds to 3600 rpm; temperature to 500F.

3. ***Damage:*** One or more rings missing from set.

Possible Cause: Bottom of the stuffing box is badly worn, and allows the packing to extrude into the system, causing possible contamination.

4. ***Damage:*** Wear on outside diameter of the packing.

Possible Cause: Rings rotating with the shaft, or coming loose in the box. Choosing the correct size of packing will eliminate this problem.

To solve any sealing problem, call on your local J-M Packing Distributor or Johns-Manville representative. They are equipped to help you select the right packing for the job—one that insures long, trouble-free service. For information, write to Johns-Manville, Box 14, New York 16, N.Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE

For more data on advertised products, use Readers' Service Cards, last page.

Stainless pressure tubing that gets white glove treatment

IF you're thinking of using stainless steel pressure tubing to solve a problem, make sure you get your money's worth. Timken® stainless steel pressure tubing is so carefully made it's literally handled with white gloves. That's typical of the quality that's built-in every step of the way. And you get this high internal quality and excellent surface finish, because:

1. **THE TIMKEN COMPANY** has one of the most modern, best-equipped seamless tube mills in the country.
2. **WE PIONEERED** in producing stainless steel tubing for pressure tube applications.
3. **MANY TECHNIQUES** we use are virtually unique in the steel industry.

Experts handle every production step—melting, piercing, finishing, testing, final inspection. The result is, you get the finest stainless pressure tubing you can buy. Tubing proved by performance in hundreds of applications.

Let Timken Company metallurgical experts help solve your stainless pressure tubing problems. You can get Timken stainless steel pressure tubing in a wide variety of sizes and grades—some not available anywhere else. Get the most for your money. Specify Timken stainless pressure tubing. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

WHEN YOU BUY TIMKEN STEEL YOU GET . . .

1. Quality that's uniform from heat to heat, bar to bar, order to order
2. Service from the experts in specialty steels
3. Over 40 years experience in solving tough steel problems

TIMKEN® *Fine Alloy* STEEL

TIMKEN ALLOY STEEL AND SEAMLESS TUBING IS AVAILABLE FROM STEEL SERVICE CENTERS IN 44 CITIES IN THE UNITED STATES

For more data on advertised products, use Readers' Service Cards, last page.

BUYING OR SELLING

Quality made Larkin the leader, and you can buy, or sell Larkin Fittings with full confidence that they are the finest fittings made.

LARKIN
...Through Your Supply Store

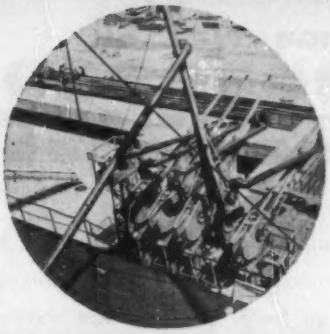
LARKIN PACKER COMPANY, INC.
WAXAHACHIE, TEXAS

LARKIN LEADERSHIP HAS BEEN EARNED BY YEARS OF DEPENDABLE PERFORMANCE

Around the World— in Port after Port...

MARACAIBO

CHIKSAN MARINE LOADING ARMS



LONG BEACH

REDUCE LOADING COSTS...

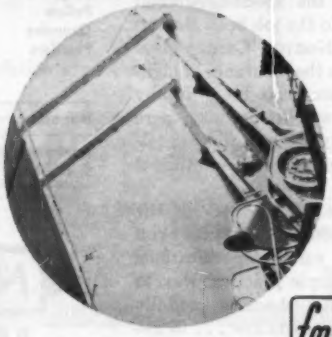
Increased efficiency and substantial cost reduction are two distinct benefits a Chiksan Marine Loading Arm brings to your tanker transfer operations. With a Chiksan Marine Loading Arm, three men can do the job that formerly required seven men and in just one-third the time.

Add to this the safety factor of all-metal lines, the drastic reduction of hose handling accidents, and hose replacement cost. Consider too, the safety and convenience of clean, uncluttered docks, and the simplifying of flanging up during bad weather. To these add the healthy savings in lower insurance and compensation premiums.

Put these benefits together and you will quickly see how Chiksan Marine Loading Arms can reduce loading costs, speed tanker turnaround time at your loading terminals. Let Chiksan submit a specific proposal for your terminal facilities. Write today.

PHILADELPHIA

SPEED TURNAROUND TIME...



KUWAIT

CHIKSAN MARINE LOADING ARM PAYOUT ANALYSIS

CHIKSAN LOADING ARMS PAY FOR THEMSELVES

An informative bulletin and a Payout Analysis are yours for the requesting. Send for your copies today.

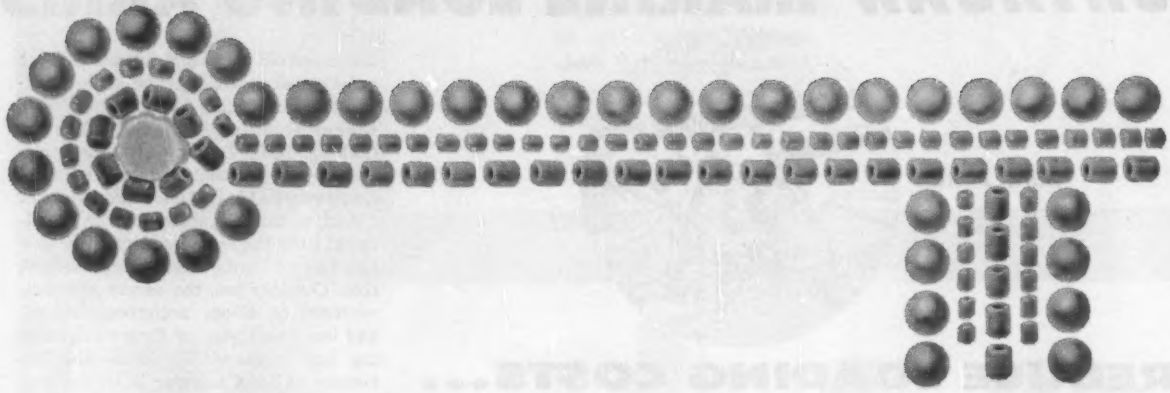
A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

fmc CHIKSAN

CHIKSAN COMPANY—BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Company • Chiksan of Canada Ltd.

#58-30



Keys to better catalysis

. . . NORTON Ceramic Catalyst Carriers

In modern chemical and petrochemical process reactions, very often the choice of proper catalyst carriers is as critical a factor as selection of the catalysts themselves. And time and again, NORTON Ceramic Catalyst Carriers have proved the *best* choice both for efficiency and economy.

It's more than just a question of a quality product. There's a personal equation involved — the Norton Man. He brings to chemical engineers the benefits of NORTON COMPANY'S years of experience in the chemical and petrochemical fields as well as the end products of its advanced manufacturing and quality control methods. He *understands* the problems involved. And, backed by NORTON COMPANY'S extensive research and engineering facilities, he's well qualified to help in their solution.

Whatever the feedstock or thermal conditions involved . . . whether reaction is in the gaseous or liquid phase . . . whether the carrier is to be coated or impregnated with the active agent, he's ready to suggest the specific NORTON product that will do the job best. He also knows that *every* NORTON Carrier gives chemical processors the assurance of highest uniformity. From lot to lot — in any quantity — size, weight, porosity, pore diameter and purity are held to close tolerances that assure precise duplication of results.

Take advantage of the service the Norton Man represents. Let him help you to meet catalyst carrier specifications exactly. It's the simple practical way to insure maximum catalyst activity and life . . . to keep catalyst costs low . . . to get optimum yield from your process. Write NORTON COMPANY, Refractories Division, 466 New Bond Street, Worcester 6, Mass.

WIDE RANGE OF TYPES AS FOLLOWS

Shapes	Materials
Spheres	Alumina
Rings	Silicon Carbide
Pellets	Fused Magnesia
Granules	Zirconia
Powders	Silica, Zircon
	Magnesia — alumina
	Spinel, etc.

Porosity — from 10% to 50%

Surface Area — from less than 1 to 70 $m^2/gram$*

*BET Method

NORTON
REFRACTORIES
Engineered . . . Rx . . . Prescribed

Making better products . . . to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — BEHR-MANNING DIVISION Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

stop-off high pressure 4", 6" and 8" lines Safely

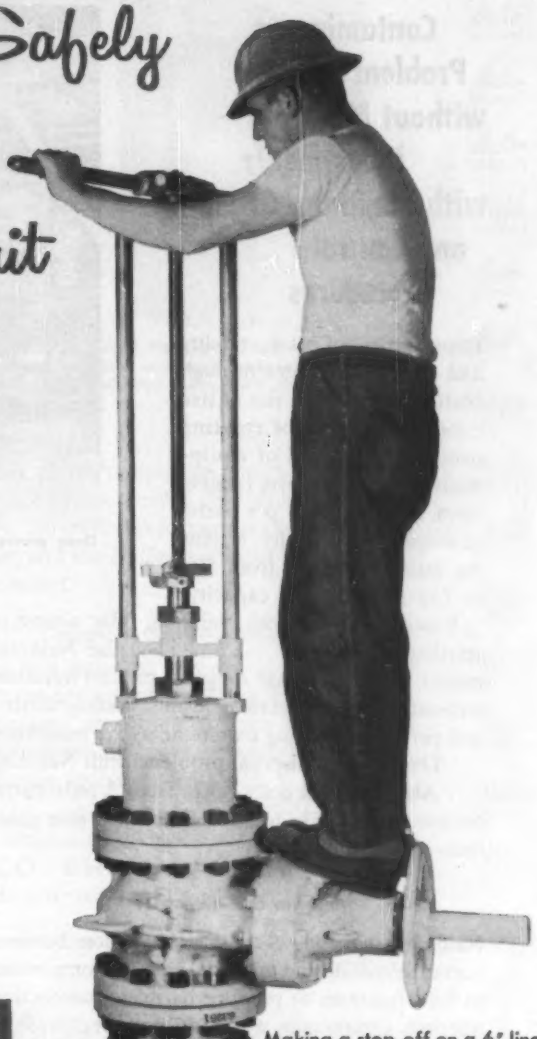
NEW MUELLER® Line Stopper Unit

No. 3SW-500

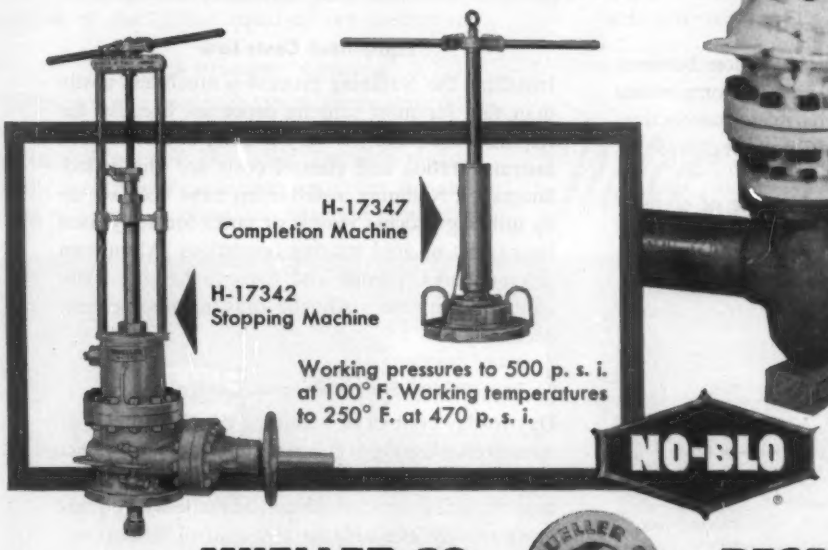
Now—Mueller Co. has developed a line stopper unit to give quick, effective, economical stop-offs of 4", 6" and 8" lines *under pressures up to 500 p. s. i.*

Unit No. 3SW-500 includes the necessary machines and equipment to make two-stop-offs at once. Convenient, built-in by-pass connection makes it easy to set up a temporary by-pass line to maintain flow in the line. Relocations, tie-ins and repairs can then be made in complete safety.

These design features are typical of the attention to detail in research, design and engineering that becomes a part of every Mueller product.



Making a stop-off on a 6" line with a Mueller H-17342 Stopping Machine.


H-17347
Completion Machine
H-17342
Stopping Machine
Working pressures to 500 p. s. i. at 100° F. Working temperatures to 250° F. at 470 p. s. i.
NO-BLO

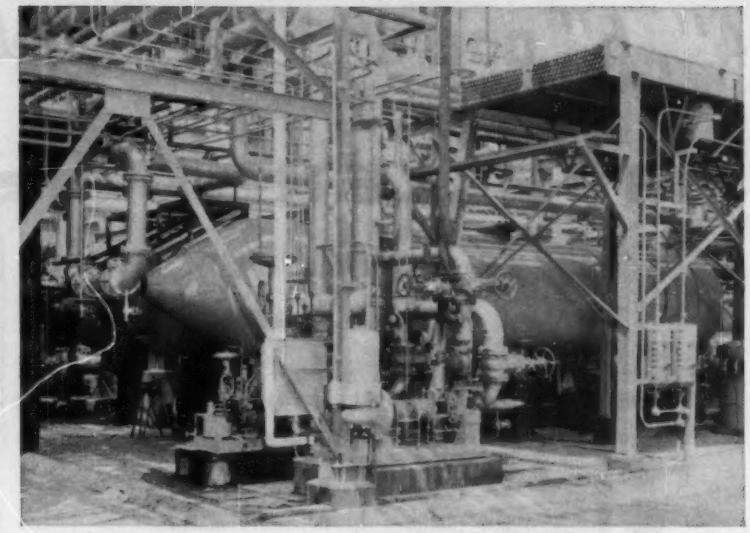
MUELLER CO. **DECATUR, ILL.**

Factories at: Decatur, Chattanooga, Los Angeles; In Canada: Mueller, Limited, Sarnia, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

Nalfining: Unique New Upgrading Method for Low-Cost Processing of Distillates

Contaminants Problem Solved without Major Investment; with Minimum Attention and Control Procedures



Three process vessels, operating in parallel, Nalfine 3,000 bpd of cat. cracked gasoline.

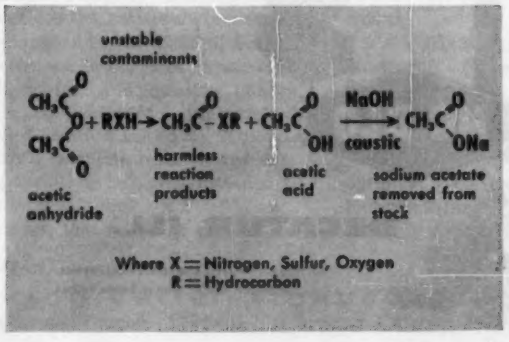
Improvement of color, stability and odor of distillates through Nalfining changes the entire economic aspect of treating processes. Instead of equipment installation costs ranging from $150 to $300 per barrel of throughput capacity, Nalfining installations run from 50¢ to 75¢ per barrel of capacity!

Processing costs with Nalfining offer almost as startling economies . . . First, because Nalfining makes possible a wide range of process variation without affecting upgrading results: testing, control and personnel training requirements are minimized . . . There are no disposal problems with Nalfining . . . And chemical costs range from 3 mils/barrel on low sulfur stocks to 3¢ to 5¢/bbl. on sour gasolines and oil stocks.

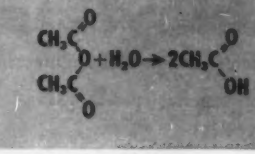
Simple Basic Process

Nalfining makes use of the interaction between acetic anhydride and unstable, reactive components in light fractions to produce harmless, unreactive, odorless compounds which do not precipitate or cause product losses.

While the complex chemical nature of components in most stocks make definite identification of reactions difficult, the following reaction offers a possible explanation of how the process functions:



Nalfining is also effective with fuels containing water haze following distillation. Apparently this is possible because hydrolysis of acetic anhydride proceeds at a slower rate than the primary reaction.



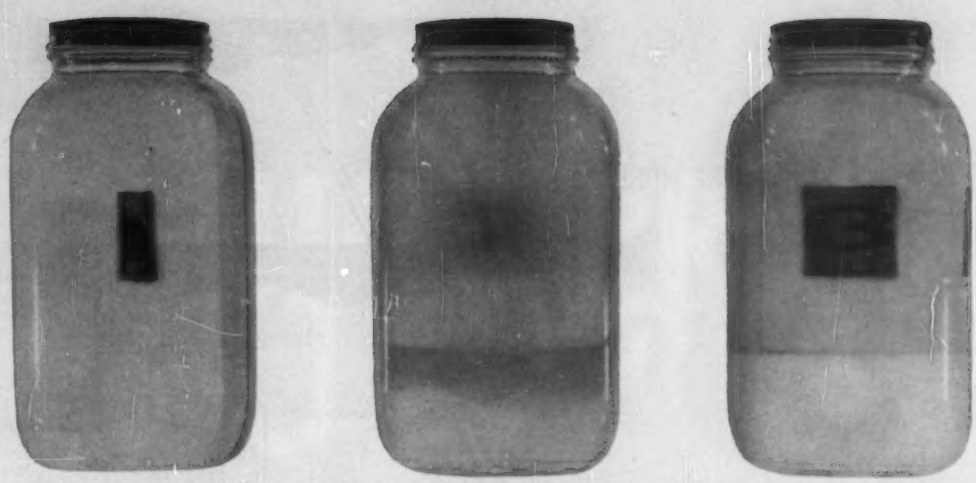
Equipment Costs Low

Installing the Nalfining process is much less costly than that for most refining processes because the required equipment is very simple, and expensive instrumentation and control costs are eliminated. Successful Nalfining installations have been set up by utilizing process vessels or tanks formerly used for caustic or acid treating operations. Aluminum storage tanks, pumps and lines to handle acetic anhydride are normally the only new equipment necessary.

Few, Simple Process Controls

Day-to-day control of Nalfining consists of simple tests to check reagent concentrations, completeness of reactions, and treated product quality. Other than these few tests, which can be made with equipment readily available in any control laboratory, and minor adjustments for operation, there are *no* other personnel needed for Nalfining . . . With reliable pumps and equipment, process upsets *do not* occur.

For more data on advertised products, use Readers' Service Cards, last page.



Jar at left (1) is raw fuel oil. Center jar (Numeral 2 obscured) is same oil with caustic added. Note haze in oil and "rag" of impurities extending from oil-caustic interface into caustic. Jar at right (3) was treated with both acetic anhydride and caustic. Stock is clear, there is no "rag" or residue at oil-caustic interface, and stabilized product will stay clear, free of objectionable odors through storage, shipment and trouble-free use.

Nalco Service Provided

All Nalfining units are provided with the regular services of Nalco Technical Representatives, who conduct tests and take samples to provide detailed information on process effectiveness, unit performance and quality of finished product. Regular reports are made to refinery personnel.

Nalfining a Wide Range of Products

Experience to date with Nalfining proves successful, low-cost upgrading of heating oils, solvents, jet fuels, gasolines, kerosenes and other distillate stocks. Throughput volumes today range from laboratory pilot plant operations to 20,000 bpd processing of light cycle oil. Nalfining itself is capable of volume of throughput equal to any desired rate.

Thorough Products "Cleanup"

Nalfining does a thorough job of deactivating distillate contaminants. Mercaptans are converted to unreactive, odorless chemicals. Unstable nitrogen, sulfur and oxygen-containing impurities are stabilized to harmless, oil-soluble reaction products.

Nalfined products have no reactive tendencies which would promote color degradation or sludge formation. No emulsion-forming occurs with water or caustic; and the Nalfined effluent has negligible sodium content.

Complete Data Available

Nalfining is a patented process which is offered under license agreement to refiners. Complete data on the process are available upon request from Nalco and we will welcome the opportunity to discuss a license agreement with you.

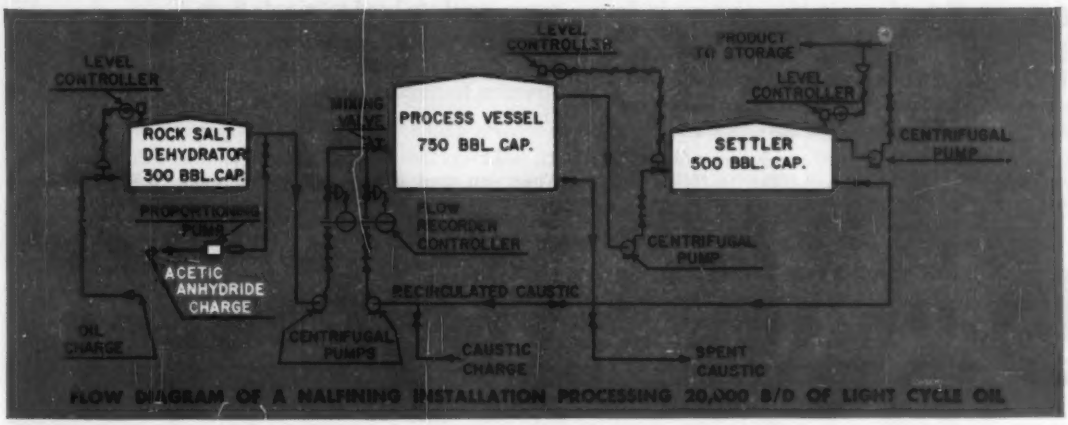
National Aluminate Corporation is now

NALCO CHEMICAL COMPANY

6259 West 66th Place • Chicago 38, Illinois

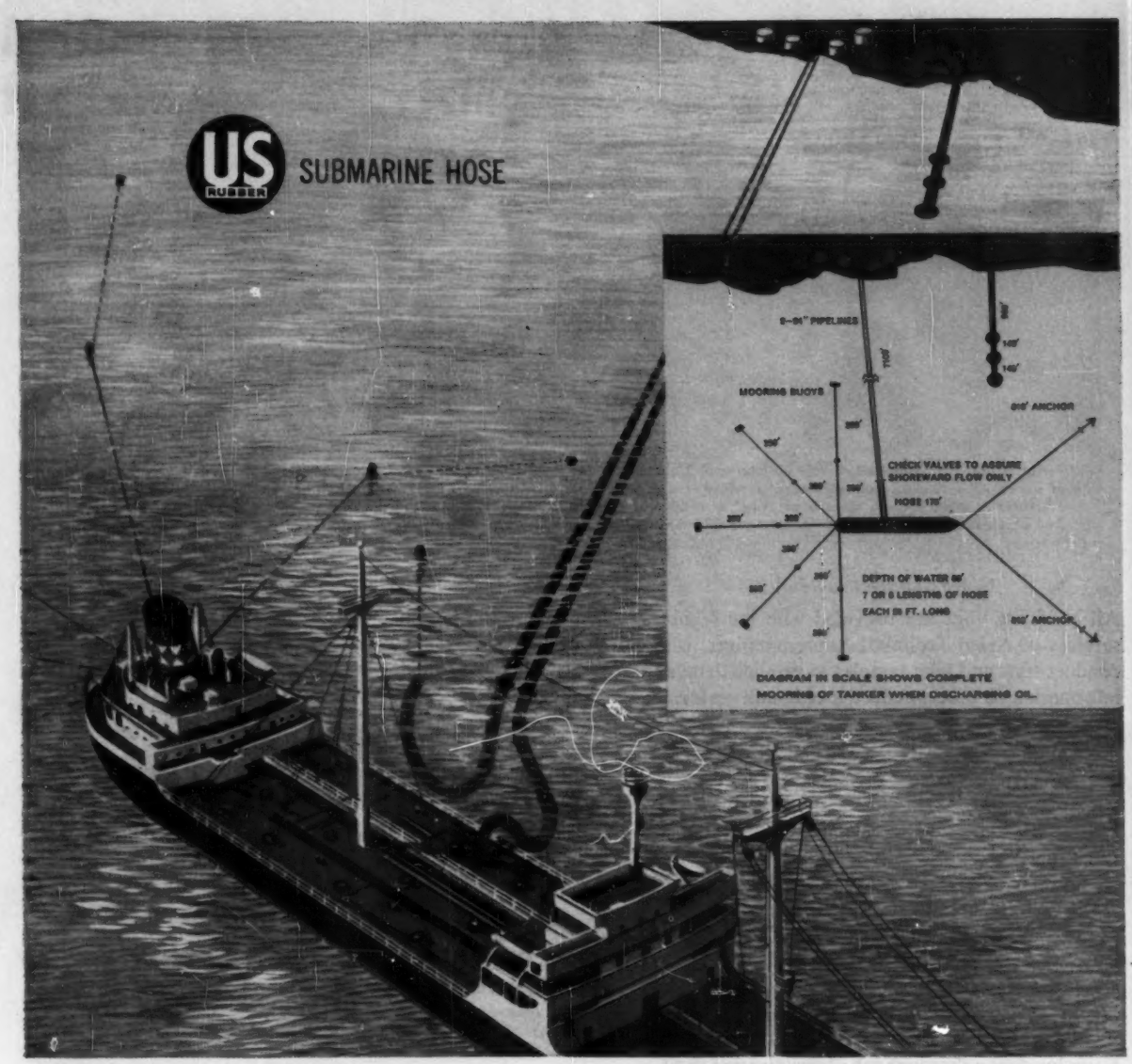
In Canada—Alchem Limited, Burlington, Ontario
Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany

Nalco® ... *Serving Industry through Practical Applied Science*



FLOW DIAGRAM OF A NALFINING INSTALLATION PROCESSING 20,000 B/D OF LIGHT CYCLE OIL

For more data on advertised products, use Readers' Service Cards, last page.


US RUBBER
SUBMARINE HOSE
8–24" PIPELINES
MOORING BUOYS
CHECK VALVES TO ASSURE SHOREWARD FLOW ONLY
HOSE 170'
DEPTH OF WATER 60'
7 OR 8 LENGTHS OF HOSE EACH 35 FT. LONG
DIAGRAM IN SCALE SHOWS COMPLETE MOORING OF TANKER WHEN DISCHARGING OIL.

From tanker to shore...the hook-up is U.S. Amazon Hose

The only submarine unloading point for oil tankers on the East Coast is at the Northville Dock Corp., Long Island, N.Y.

The operators say that submarine unloading would be impossible without hose of this character. Foreign and domestic tankers use this undersea hose (7100 feet offshore) as a hook-up to pipelines discharging heavy and light fuel oil directly into storage tanks on shore. Expensive dock and wharfage facilities are eliminated. *The tankers are moored at sea.*

The U. S. Amazon® Hose H2323 in use here resists the corrosive action of salt water and the turbulent action of swift tides. Its lightness and flexibility enable crew members to make it fast to the deck headers in record time. Also it curves easily from the water to the deck. There is never any sharp bend to impede flow.

Similar installations for other oil companies are located at world-wide points, proving the soundness of the construction features and the over-all quality of U. S. Amazon Hose.

• • •

When you think of rubber, think of your "U.S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

US RUBBER

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

HIGH PROFIT SULFUR FROM LOW PRICE PLANTS

Badger engineers help refiners convert H_2S... a by-product "nuisance"... to profitable elemental sulfur

There is a difference in sulfur plants — especially when you consider contractor services. Badger, through its Key Man Service, offers a *complete* design, engineering, construction and operation package. This proposal-to-product service plan provides you with a simple, functional plant that costs less to build and operate, produces high yields.

Badger's staff includes engineers who have been building successful sulfur recovery plants since 1948. Within the past thirty months plants have been completed for Socony Mobil Oil Co. (Paulsboro, N. J.) and Montana Sulfur & Chemical Co. (Billings, Mont.). Both plants were built at low cost to produce high profit sulfur economically.

If sulfur recovery is in your future, Badger belongs in your plans. For more complete information, write or phone today. Badger Manufacturing Company, 363 Third Street, Cambridge 42, Massachusetts.

***built by* BADGER**

INTERNATIONAL DESIGNERS • ENGINEERS • CONSTRUCTORS

THE BADGER COMPANIES

Badger Manufacturing Company Cambridge • New York • Houston • Canadian Badger Company Ltd. Toronto, Ontario, Canada • Badger N.V. The Hague, Holland • Badger Limited London, England • Badger (Belgium) S.A. Brussels, Belgium • Badger (France) S. à R.L. Paris, France

300 S

ANNUAL EDITION OF

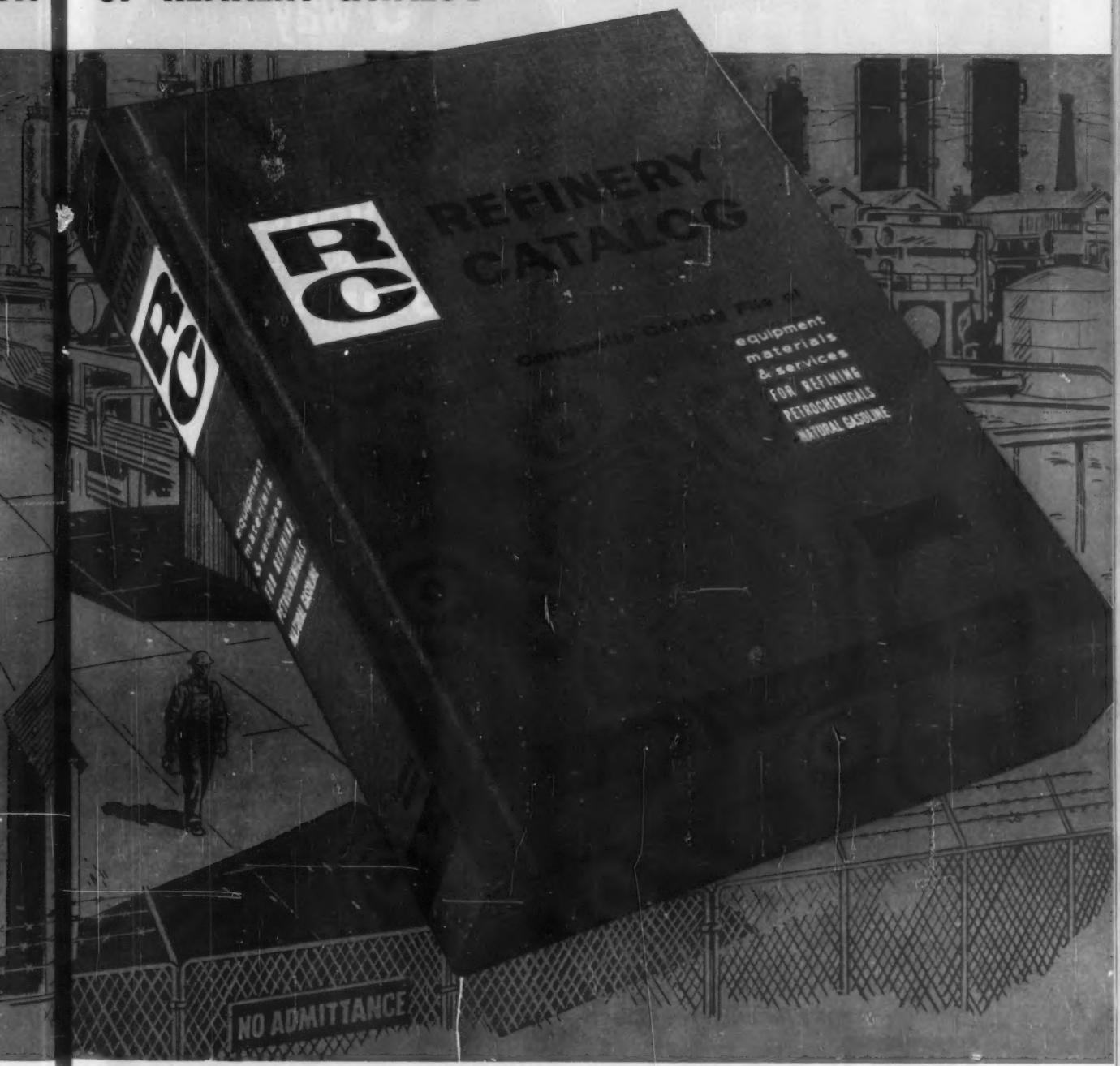
EQUIPMENT • MATERIALS • SERVICES
for REFINING • NATURAL GASOLINE • PETROCHEMICALS

In a hurry? Eight out of nine planners, buyers and specifiers turn to REFINERY CATALOG in preference to individual suppliers' literature when figuring a job. They know that REFINERY CATALOG is always current, that it's indexed and cross-indexed for quick, accurate reference. That's why more than 300 manufacturers and service companies put their complete or condensed catalogs in REFINERY CATALOG. Here they are "on call" 24 hours a day.

The next time *you* have a procurement problem, reach for a quarter-century of cataloging experience—look *first* in the one volume, easy-to-use REFINERY CATALOG.

SUPPLIERS ON CALL

OF REFINERY CATALOG

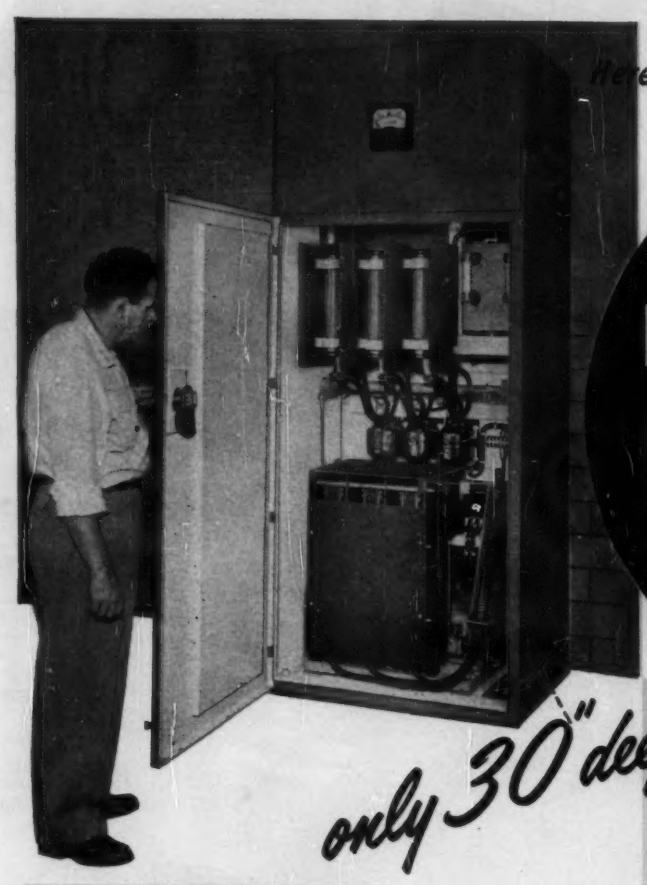


REFINERY CATALOG

Published by Petroleum Refiner

For more data on advertised products, use Readers' Service Cards, last page.

Here is **DESIGN LEADERSHIP...** *in Action!*



3-way Padlock Protection WITH EC&M Air-Break High Voltage (2200-4800 VOLTS) Starters

only 30" deep!

Accessible from Front...

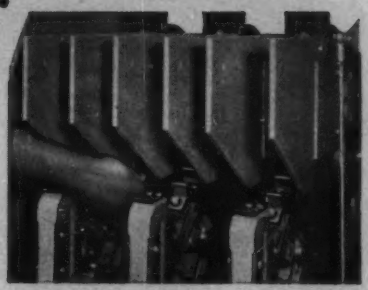
(Solid back) • Starters may be mounted against wall or in double row, back to back

ECaM's door-and-disconnect interlocking system gives you 3-way padlocked safety. The gang-operated Disconnect Switch may be padlocked (1) in the "ON" position or (2) in the "OFF" position—both with the starter door closed. (3) The door opens only by backing out captive thumb screws after the contactor and disconnect are open. For COMPLETE SAFETY—Disconnect Switch blades engage grounding clips in the open position.

ECaM's simple interference interlock permits manual operation of the contactor to check contact alignment, shaft rotation, and electrical interlock engagement. No roll-out is needed for any maintenance—contacts, operating coil, and control contacts are fully accessible within the enclosure.

ECaM starters are furnished with a control transformer. Since the bus is located in an isolated upper compartment, only one feeder is required for a group of starters.

***Write for* BULLETIN 8130**



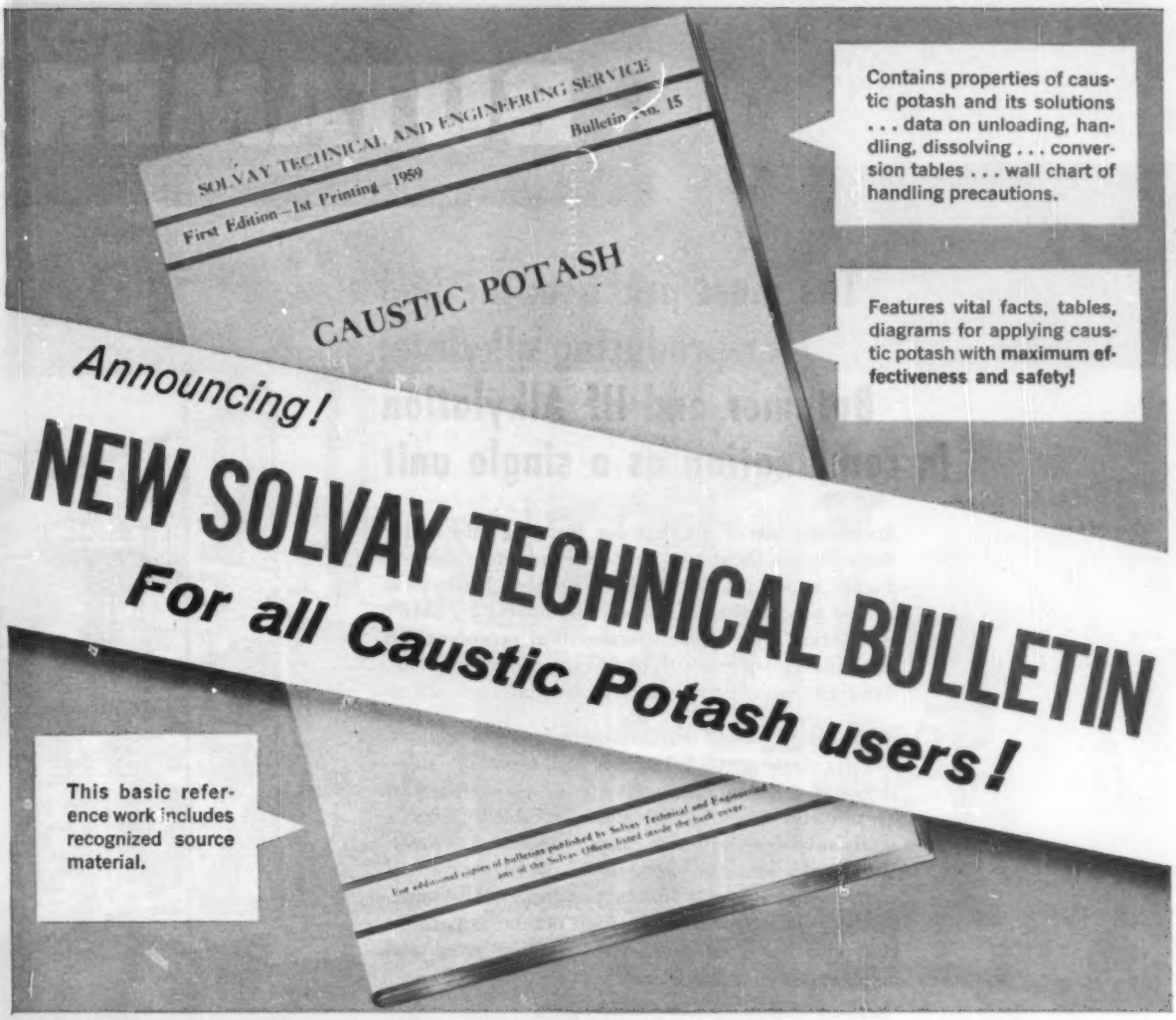
NO DRAW-OUT NEEDED • Arc shields slide out horizontally, making front and rear contact-tips removable with standard wrench.

3 Interrupting Ratings for Squirrel Cage, Synchronous and Wound-rotor Motors

1. **CLASS E 1** • 50,000 KVA (symmetrical) based on certified tests.
2. **CLASS E 2** • With current limiting fuses and high interrupting capacity contactor. At 2300 volts: 150,000 KVA, 3 phase; 60,000 RMS amperes asymmetrical. At 4,800 volts: 250,000 KVA, 3 phase; 60,000 RMS amperes asymmetrical.
3. **VALIMITOR®** • May be used on a bus of unlimited short circuit capacity, through the use of a contactor with an interrupting rating of 50,000 KVA, and reactors which limit any fault current to a maximum of 25,000 KVA.

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

7955-R


SOLVAY TECHNICAL AND ENGINEERING SERVICE
First Edition—1st Printing—1959
Bulletin No. 15
CAUSTIC POTASH
Contains properties of caustic potash and its solutions . . . data on unloading, handling, dissolving . . . conversion tables . . . wall chart of handling precautions.
Features vital facts, tables, diagrams for applying caustic potash with maximum effectiveness and safety!

Announcing!

NEW SOLVAY TECHNICAL BULLETIN

For all Caustic Potash users!

Now America's foremost producer of alkalies—Solvay—brings you an authoritative, helpful source-book of the latest information on caustic potash. And it's a *completely new* addition to your Solvay reference library . . . in the great tradition of Solvay Technical and Engineering Service Bulletins.

Fill in the coupon for your copy, and indicate any other Solvay technical bulletins you might find useful.

Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N. Y.

SOLVAY® branch offices and dealers are located in major centers from coast to coast.

SOLVAY PROCESS DIVISION
ALLIED CHEMICAL CORPORATION
61 Broadway, New York 6, N. Y.

Please send me without cost your new Bulletin 15, Caustic Potash, as well as the other Solvay bulletins checked below.

- ☐ #4—Calcium Chloride in Refrigeration
- ☐ #5—Soda Ash
- ☐ #6—Caustic Soda
- ☐ #7—Liquid Chlorine
- ☐ #8—Alkalies and Chlorine in the Treatment of Municipal and Industrial Water
- ☐ #9—The Analysis of Alkalies
- ☐ #11—Water Analysis
- ☐ #12—The Analysis of Liquid Chlorine and Bleach
- ☐ #14—Chlorine Bleach Solutions
- ☐ #16—Calcium Chloride

Name_____

Position_____

Company_____

Phone_____

Address_____

ED-79

City_____ Zone_____ State_____

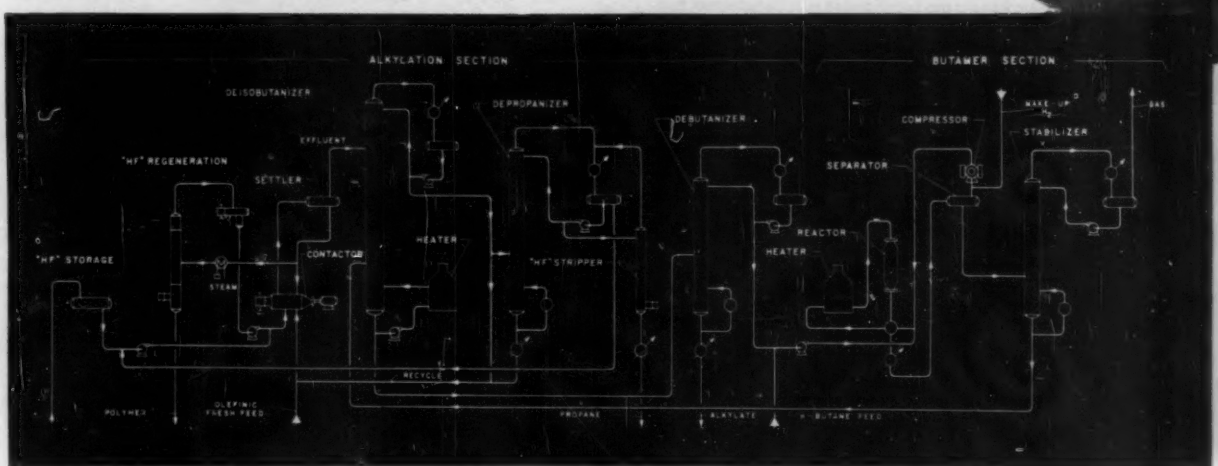
BUTAMER*

The most practical method for producing alkylate: Butamer and HF Alkylation in combination as a single unit

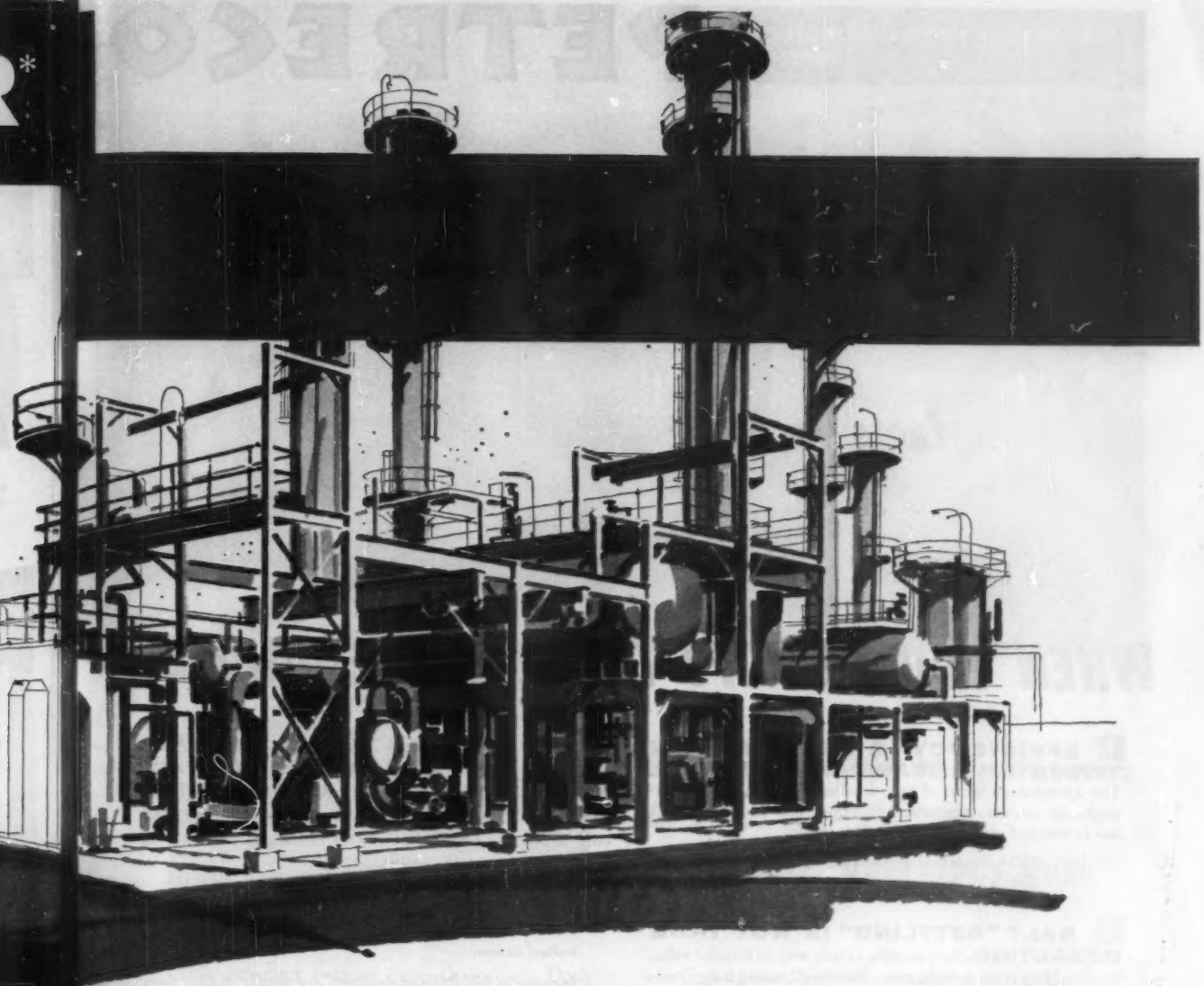
Increasing use of alkylate for blending into motor fuels makes these two up-to-the-minute processes highly important to petroleum refiners. Butamer is a new process for producing isobutane . . . "HF" Alkylation is an efficient, economical process which combines isobutane with olefins to produce alkylate, much in demand today as a motor fuel component.

With the advent of high compression ratio engines, usually starting at 9.5:1, motor fuel, especially those deficient in isoparaffins, have been associated with an unusual engine noise called "rumble." Further study reveals this rumble can be eliminated through the use of a better balanced fuel, namely using a fuel composed of a greater volume percentage of isoparaffins. Alkylation produces a high octane isoparaffin that also has good sensitivity, ignition point and combustion characteristics.

*Trademark



More Than Forty Years Of Leadership In Petroleum Refining Technology



Butamer—Heart of this process is a noncorrosive, stable and rugged platinum-containing catalyst especially developed by UOP. Capable of operating at relatively low temperatures, its use assures a sufficiently high concentration of isobutane in the reactor effluent to eliminate excessive recycle of normal butane.

Operating under hydrogen pressure, with low hydrogen-to-charge ratio, the high catalyst activity results in economical liquid hourly space velocities, thus requiring only a modest catalyst inventory. The mild operating conditions further assure minimum loss to by-products.

HF Alkylation—"HF" Alkylation is a catalytic process which combines olefins such as propylene, butylenes, and amylenes with isoparaffins (usually isobutane) to form a mixture of branched chain hydrocarbons of higher molecular weight known as alkylate for aviation and motor fuel.

These two processes are readily and economically integrated. Together, they form the ideal, most practical method for producing alkylate.

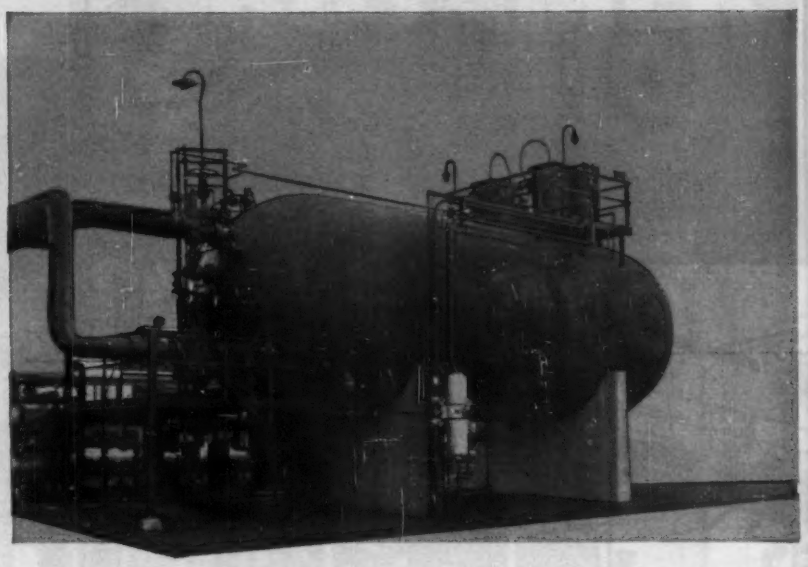
Write for detailed information. Ask also about other UOP refining and petrochemical processes, available to refiners everywhere, for improving operating efficiency and producing better and more profitable petroleum products.

UOP®

UNIVERSAL OIL PRODUCTS COMPANY

30 Algonquin Road, Des Plaines, Illinois, U.S.A.

PRODUCT IMPROVEMENT WITH **PETRECO**



facts to consider

WHEN YOU SPECIFY DESALTING EQUIPMENT

1 EFFICIENCY IS MEASURED IN TERMS OF REMAINING IMPURITIES. The ultimate measure of any desalting process is its thoroughness in removing salts and impurities—*not how much salt is removed, but how much salt is left in.*

PETRECO* all-electric desalters consistently deliver desalting results with residual impurities in the 0 to 1 ptb range.

2 SALT "SETTLING" IS NOT TRUE DESALTING. Salt settling is one way to remove salts, but desalting is something else. "Settling", using long "residence time" in large volumetric capacity settlers, was one of the first methods ever used to remove salts.

Petreco all-electric desalting is an engineered method for the extraction of salts from crude oil. The mixture of the oil and salt-bearing brine is combined precisely with the correct amount of fresh water, and exposed to the powerful forces of the electric field to achieve fast, efficient separation.

3 TIME, DISTANCE AND SETTLING SPACE ARE NOT IMPORTANT FACTORS IN PETRECO ALL-ELECTRIC DESALTING. These natural developments are vital only to desalting methods wherein settling is necessary to the functioning of the process.

In Petreco all-electric desalting, engineered emulsification, distribution and demulsification bring about rapid, controlled action.

Because of this, Petreco desalters are usually smaller than vessels used in less advanced methods. This means savings in the cost of the vessel required, the amount of piping and the ground area needed—and yet provides a maximum yield in salt removals.

Remember—when you specify your next desalting installation, there is no substitute for Petreco's engineering design.

*PETRECO *is a registered trade mark of Petrolite Corporation.*

DS-59-1

PETROLITE CORPORATION

PETRECO DIVISION

3202 South Wayside Drive (P.O. Box 2546), Houston 1, Texas
1390 East Burnett Street (P.O. Box 7216), Long Beach 7, California

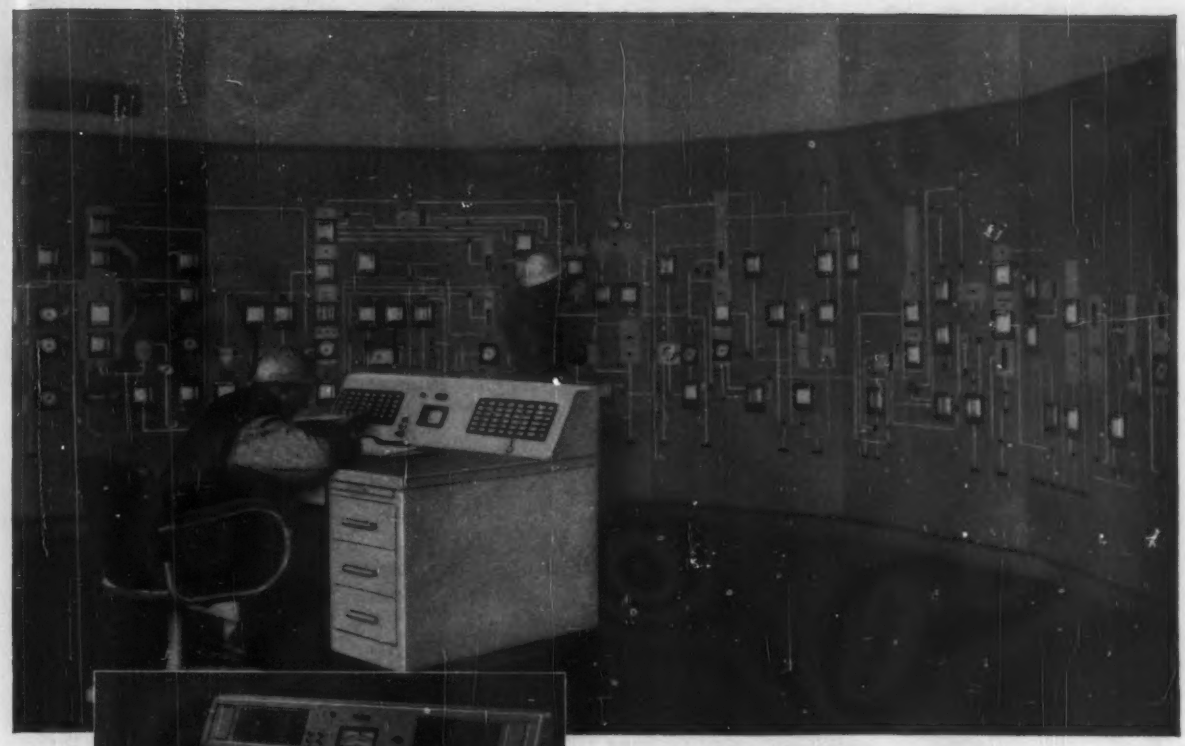
CANADA: Petreco, 4528 Stanley Drive, Calgary, Alberta

ENGLAND: Petrolite Limited, 46 Mount Street, London, W. 1

VENEZUELA: South American Petrolite Corporation, Hotel Avila, Caracas

REPRESENTATIVES

BRAZIL: WERCO, Ltda., Avenida Rio Branco 57-s/1410-11, Rio de Janeiro
COLOMBIA: South American Petrolite Corporation, Calle 19, No. 7-30, Office 807, Bogota
ITALY: O. Wagner, 149 Via Nemorense, Apt. 1, Rome
JAPAN: Chiyoda Chemical Engineering and Construction Company, Ltd., Tokyo Bldg., No. 3, Marunouchi 2-Chome, Chiyoda-Ku, Tokyo
KUWAIT: F. N. Dahdah, Box 1713, Al Kuwait
MEXICO: R. E. Power, Sierra de Mijes, No. 125, Mexico D. F.
NETHERLANDS: F. E. C. Jenkins, Hoefbladlaan 134, The Hague
TRINIDAD: Neal and Massy, Ltd., Port of Spain, P. O. Box 544



Read up to 288 temperatures at this Honeywell "Operator's Desk"

This compact console type Operator's Desk makes it possible, from one central location, to read as many as 288 thermocouple points, or 192 points with identifying card holders. Its *ElectroniK* Precision Indicator and switch assemblies are mounted for ease of reading whether the operator is sitting or standing.

The *ElectroniK* Precision Indicator, accurate to 1/8 of 1% of full scale, can be of single range, double range or extended range type. Use it with all types of thermocouples, millivolt actuation, or a combination of the two. The desk can be supplied with a telephone dial system for thermocouple selection, rather than key or pushbutton switches. Additional equipment such as lights and clocks can be built in.

Servicing is simplified. Instrument and switch terminal blocks are in the lower rear portion of the desk, readily accessible from the back of the console. All wiring enters from the bottom of this compartment.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

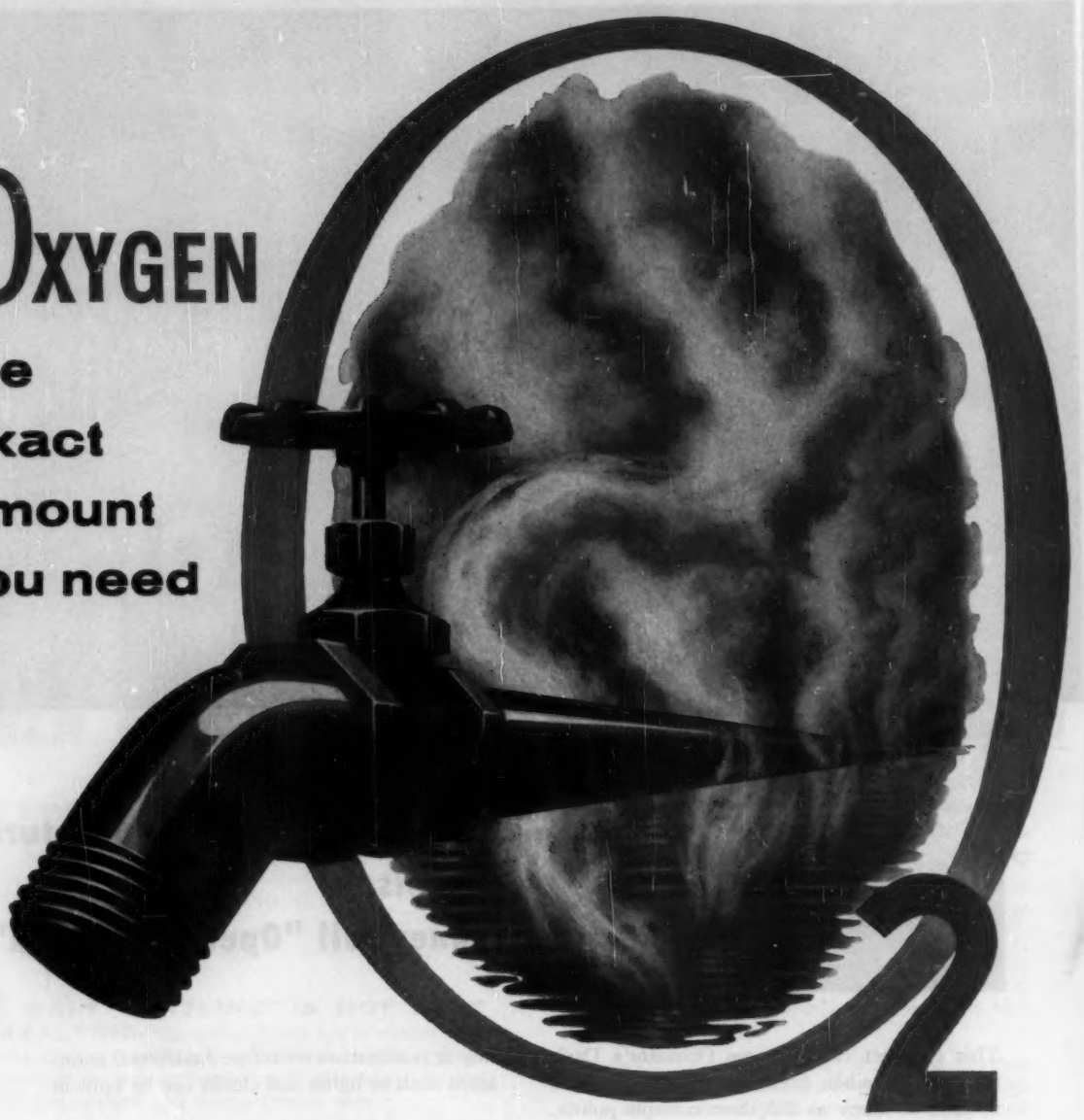
Honeywell

H HONEYWELL *First in Control*

For more data on advertised products, use Readers' Service Cards, last page.

OXYGEN

the exact amount you need



You get it instantly—from LINDE

You have no worries whatever about an ample, dependable supply of oxygen for your process when you buy oxygen from LINDE. Full responsibility for production, transportation, and storage at your plant is assumed by LINDE.

Tonnage oxygen. Large amounts of liquid or gaseous oxygen can be supplied from a full-scale oxygen production unit—built and maintained by LINDE—directly to your plant. You pay only for the oxygen you use, at a price guaranteed by LINDE, with no capital investment on your part.

For varying needs. A DRIOX oxygen storage unit provides a continuous flow of liquid oxygen, or converts it automatically to gas. Constant pressure is maintained, even while the unit is being replenished. Or you can get LINDE oxygen in a single flask, a cylinder, or banks of cylinders.

Take advantage of LINDE's 50 years of development and service in the industrial gas field! Write, phone, or wire Dept. PR-7. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

When you need Oxygen—call LINDE!

Linde TRADE-MARK

UNION CARBIDE

The terms "Linde," "Driox," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

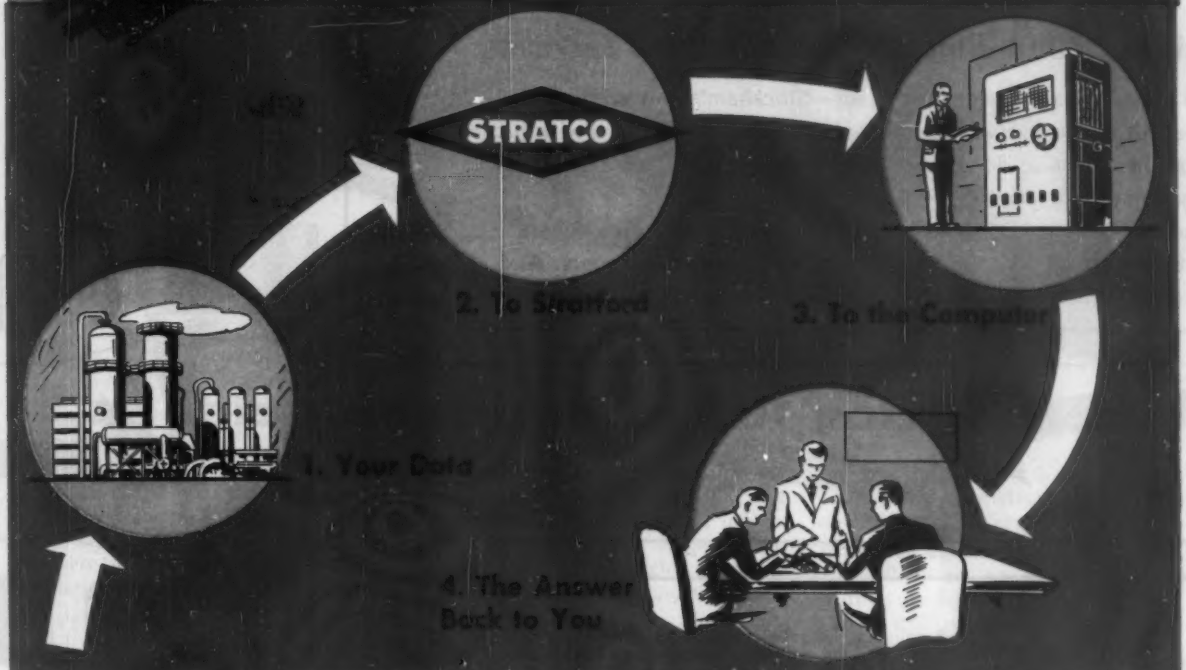
STRATFORD NOW OFFERS

ELECTRONIC COMPUTATION . . .

To Provide Optimum Process Designs of

STRATCO

EFFLUENT REFRIGERATED* ALKYLATION UNITS



Accurate Information Furnished Quickly on the Best Design to Fit Your Feed Stock and Other Requirements

There is no cost or obligation involved. Just send us your data and we provide process flow diagrams with complete overall material balances best suited for your operation . . . ordinarily within 48 hours.

Alternate designs to fit various feed stocks, octane levels and other conditions, available if desired. Contact us for details of this time and money saving service.

Representatives

D. D. Foster Co., Pittsburgh
D. D. Foster Co., So. Charleston, W. Va.
Lester Oberholtz, Los Angeles
Rawson-Houlihan Co., Inc., Houston
The Rawson Co., Inc., Baton Rouge
F. J. McConnell Co., New York

*Licensed by Stratford Engineering Corporation. We cooperate with your contractor in plant design.

STRATFORD ENGINEERING Corporation

512 West 47th St. — PETROLEUM REFINING ENGINEERS — Kansas City 12, Mo.

For more data on advertised products, use Readers' Service Cards, last page.

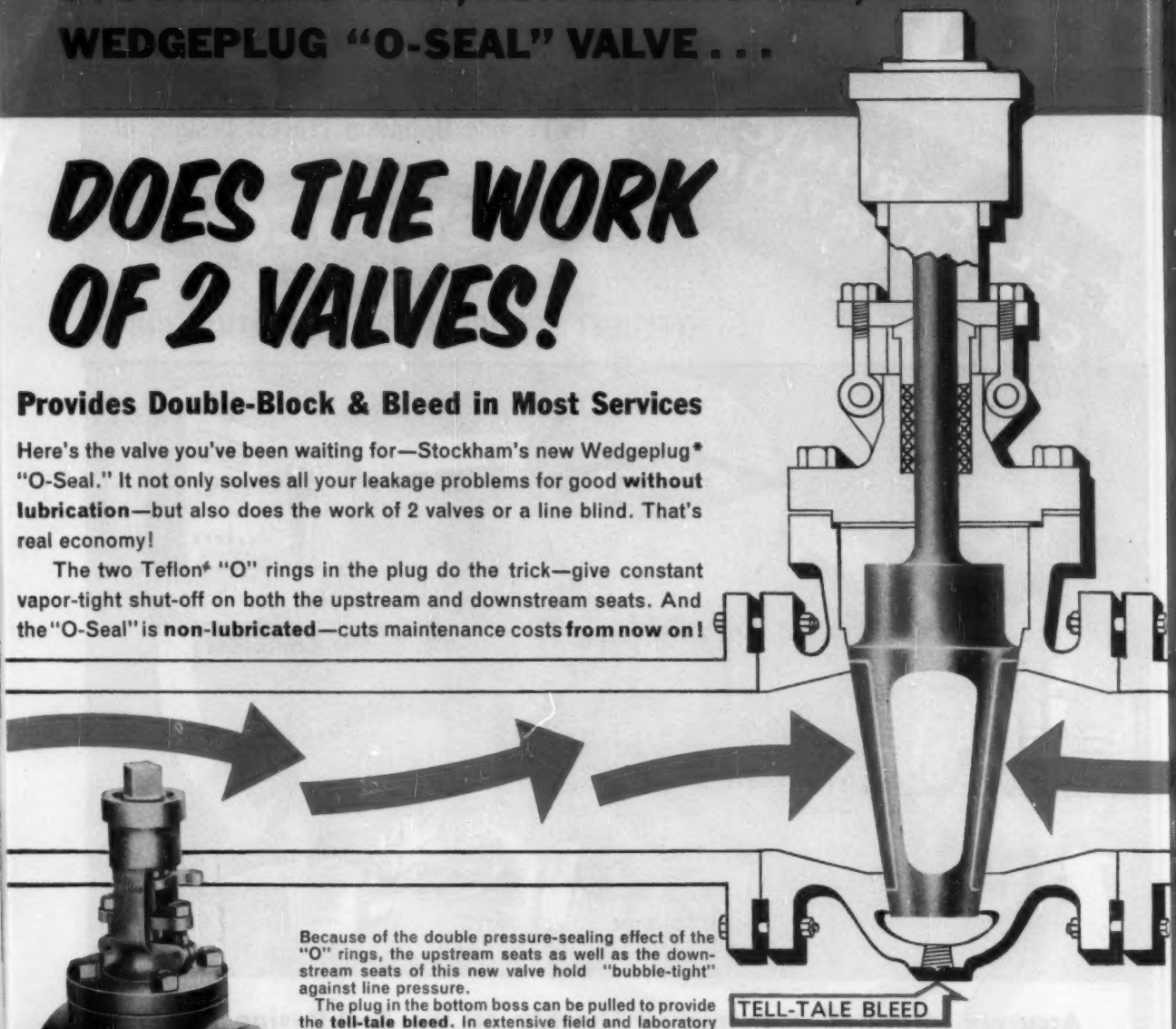
STOCKHAM'S NEW, NON-LUBRICATED, VAPOR-TIGHT WEDGEPLUG "O-SEAL" VALVE . . .

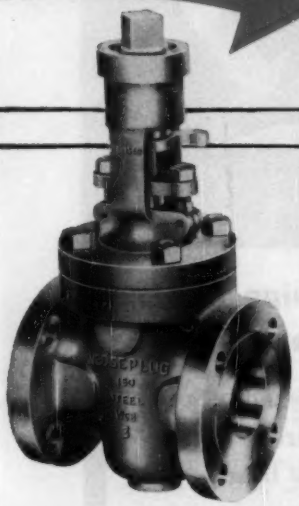
DOES THE WORK OF 2 VALVES!

Provides Double-Block & Bleed in Most Services

Here's the valve you've been waiting for—Stockham's new Wedgeplug* "O-Seal." It not only solves all your leakage problems for good **without lubrication**—but also does the work of 2 valves or a line blind. That's real economy!

The two Teflon† "O" rings in the plug do the trick—give constant vapor-tight shut-off on both the upstream and downstream seats. And the "O-Seal" is **non-lubricated**—cuts maintenance costs **from now on!**





Because of the double pressure-sealing effect of the "O" rings, the upstream seats as well as the downstream seats of this new valve hold "bubble-tight" against line pressure.

The plug in the bottom boss can be pulled to provide the **tell-tale bleed.** In extensive field and laboratory tests, this valve held bottle-tight on the upstream as well as the downstream seats when the bottom plug was removed. There is absolutely no mixing of products in manifolds.

Thus the "O-Seal" can do the job of two ordinary valves or a line blind in most services.

Your Stockham representative will advise you about the recommended services for the "O-Seal's" double-block and bleed feature.

RECOMMENDED USAGES

Stockham's new "O-Seal" is recommended for all g services—air, gas, water, steam, propane, hydrocar etc., as well as for hard-to-hold services. Recommend temperatures from minus 300° F to plus 400° F and not exceeding 720 psi.

Available in carbon and alloy steels, 2"- 12" sizes, 1 300 lb. pressures. Three port openings—40%, 70% round-wrench, handwheel, gear, and motor operated.

OTHER OUTSTANDING ADVANTAGES — **Non-Lubricated—no costly maintenance necessary • Absolute shut-off that remains permanently "bubble tight" • Quick, easy operation—won't stick—ever • Double Seating for Double Safety—Ground metal-to-metal seat provides shut-off in case fire burns out "O" rings • No Product Contamination-Protected Seats.**

*Patented
†Teflon: Dupont

STOCKHAM'S NEW WEDGEPLUG "O-SEAL" VALVE

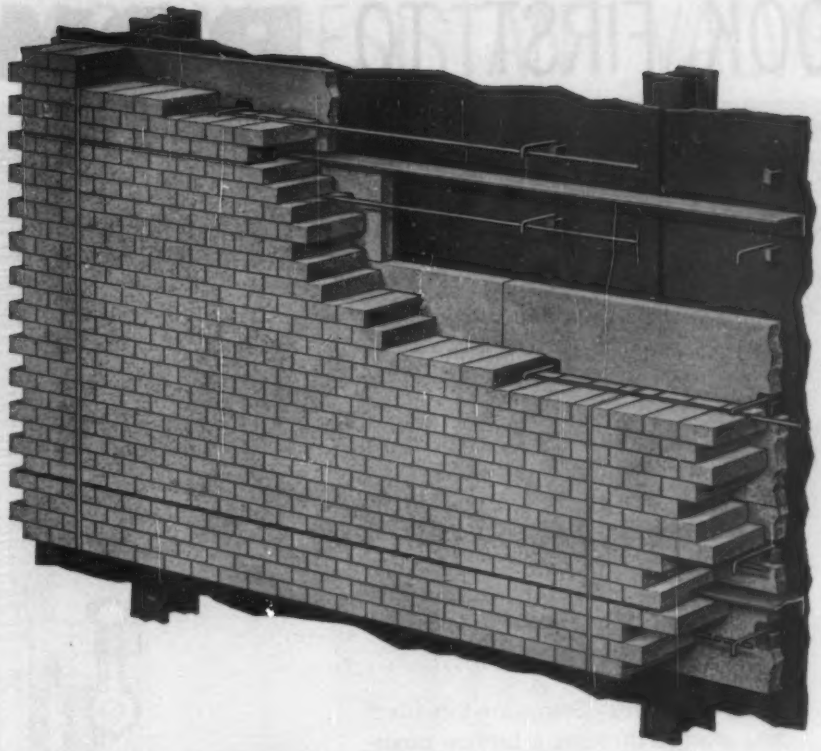
Call your STOCKHAM Distributor or Sales Representative for complete details, or write today for the new brochure on the Wedgeplug "O-Seal."

Stockham makes a *better* valve . . . for *every* job

WEDGEPLUG VALVE COMPANY *Division of* → **STOCKHA VALVES *and* FITTIN**

General Offices and Plant / 4003 North 10th Avenue, Birmingham 2, Alabama

CAST IRON—MALLEABLE PIPE FITTINGS • BRONZE, CAST IRON, DUCTILE IRON, CAST AND FORGED STEEL VALVES



B&W Insulating Firebrick sectionally supported wall construction, horizontal rod-type anchoring

Can this construction cut your costs?

Simplified design and lower material costs in initial construction, ease of installation and maintenance, reduced downtime and economy of operation—these are the benefits of this *lightweight* insulating firebrick construction.

Here's what lightweight means. Compared with dense fireclay refractory materials that weigh from 125 to 140 lb per cu ft, lightweight insulating firebrick weigh approximately 26 lb per cu ft for B&W's 2000 degree brick. This difference provides two major advantages: (1) mechanical, which largely affects design and construction, and (2) thermal, which saves in maintenance, downtime and operation.

Savings in design and construction

The use of lightweight IFB simplifies engineering requirements and reduces costs. A minimum of detailing is needed, since the design is engineered around one standard shape — a feature of B&W IFB constructions.

Material requirements are simplified, too. B&W IFB can be tailor-cut, drilled or shaped as necessary, eliminating the need for costly special fired shapes, and the delays in obtaining them. Typical sections, such as burner openings, observation ports and tube supports, can be cut and shaped on the job in minutes, using ordinary woodworking tools.

Substantial savings are possible in structural steel, since insulating firebrick roof and wall constructions are lighter. In locations with soil of poor load bearing capacities, this lightweight may also result in reduced foundation costs.

These savings, coupled with B&W's engineering and service facilities available during the design phase, mean lower initial costs.

Savings in maintenance, downtime and operation

Lightweight IFB offer a major thermal benefit—they store and conduct less heat. Heavy refractories retain heat; in the event of forced shutdown, they can cause burn-out of expensive alloy tubes, where used. The low quantity of heat stored by B&W IFB can be quickly dissipated, thus protecting these expensive tubes.

Further, this low heat storage permits faster heating and cooling. This means quicker access to the furnace in the event of emergency shutdown. Your maintenance crew can get in the furnace sooner and get it back on stream faster.

Supplied from nearby warehouses

With the use of simplified IFB constructions, refractory repairs can be quickly and easily accomplished with standard shapes from a nearby warehouse. This eliminates costly delays in obtaining special shapes.

Anchoring devices, too, are simplified. Since there are no expensive special castings in B&W IFB constructions, carbon steel or low alloy rods can be used. These are generally available from any local steel warehouse.

Increased efficiency

Generally, the lighter a firebrick the better an insulator it is. Since B&W IFB are the lightest insulating firebrick made, they are the most efficient insulators. Per inch of thickness, B&W IFB provide more insulation than any other refractory material. The result is that for walls of equivalent thickness less heat is lost with B&W IFB. Casing temperatures are lower, thus improving working conditions. This means increased efficiency and reduced operating costs.

R 838

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

For more data on advertised products, use Readers' Service Cards, last page.

LOOK FIRST TO **POWELL**

Features of Construction:

Powell Corrosion Resistant Valves are made in stainless steel, Monel, nickel, Hastelloy alloys, aluminum and other special corrosion resisting metals.

Solid and double wedge discs of gate valves are interchangeable. They are precision machined and fitted and are accurately guided throughout their entire travel. This prevents drag of the disc over the seat faces, eliminating wear of seating surfaces and stops undue vibrational noises.

O.S.&Y. Valves—Stems are threaded and guided through a bronze bushing in upper yoke. (Bushings made of other alloys can be supplied on special order.) A compression lubricant fitting in upper yoke is provided to lubricate the stem and bushing threads and to reduce wear. A convenient shelf is cast on the inner sides of yoke arms for suspending the gland when renewing the packing.

All valves are regularly packed with Teflon Packing. Globe and "Y" valves are available with metal or Teflon discs.

Globe, Angle, Gate and "Y" valve stems are back seated for repacking under pressure when fully open.

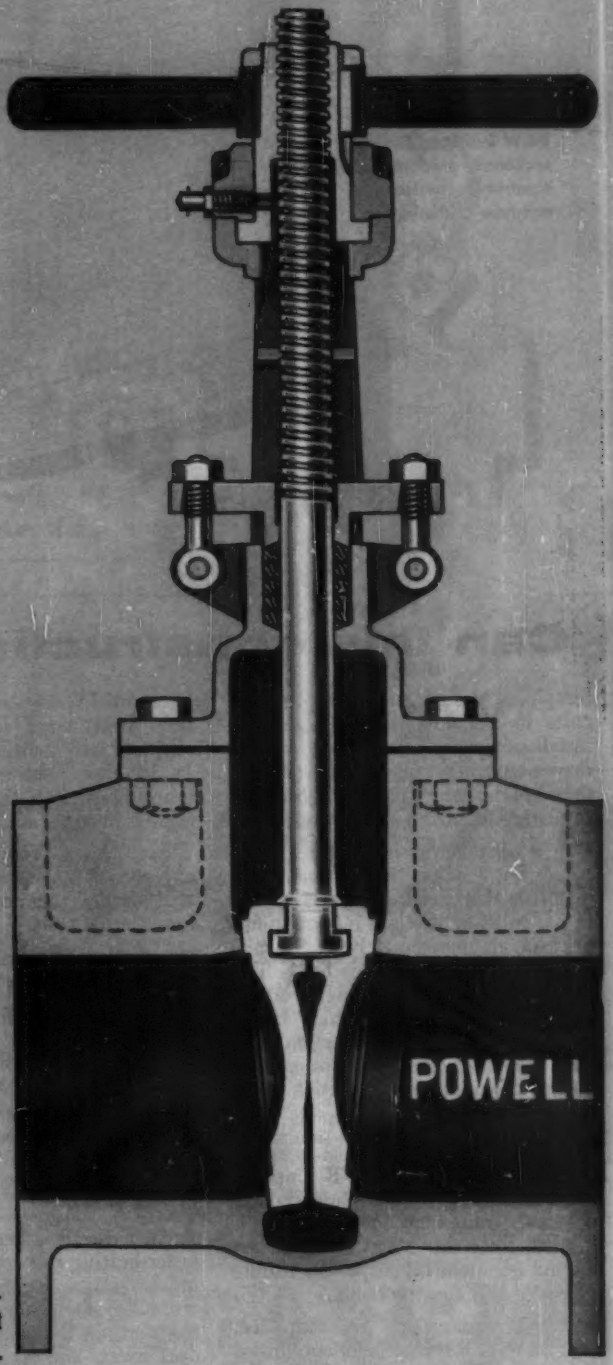


Fig. 2453 DG (Sectional)—Large Stainless Steel O.S.&Y. Gate Valve. Available with interchangeable solid or split wedges. Wedges are fully guided throughout their travel.

POWELL...world's largest family of valves

FOR CORROSION RESISTANT VALVES

Over a quarter century ago, Powell introduced the Corrosion Resistant Valve. Now, after years of pains-taking experiments and exhaustive research, Powell offers Valves to handle practically every corrosive fluid—valves of every design, and in the largest possible selection of metals and alloys.

For all your flow control requirements—water, oil, gas, air, steam, as well as corrosive fluids—Powell has the right valve in the right size and the right metal. Consult your local Powell distributor or write directly to us.

Fig. 2633—Large, Stainless Steel Swing Check Valve for 150 W.P. Sizes, 2" to 12".

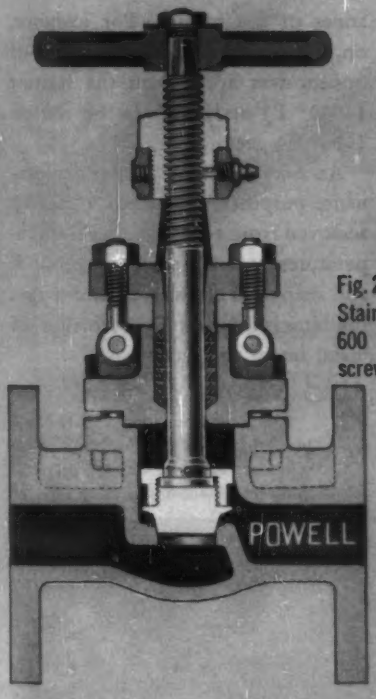


Fig. 2475 (Sectional)—150 W.P. O.S.&Y. Stainless Steel Globe Valve. 300 and 600 W.P. also available. ¼" to 3"—screwed and flanged ends.

Fig. 2106 (Sectional)—150 W.P. O.S.&Y. Stainless Steel "Y" Valve. ¼" to 3"—screwed and flanged ends. 300 W.P. valves also available.

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

Mold a Heat-Saving Overcoat on Hard-to-Fit Shapes with ...BALDWIN-HILL

No. 1 INSULATING CEMENT

On such complicated shapes as this steam turbine shell and its exhaust piping at Philadelphia Electric Company's Schuylkill Station, B-H No. 1 Insulating Cement was applied easily and quickly to the irregular surfaces.

Because No. 1 Cement is effective to 1800° F, applicators were able to apply the proper thicknesses of insulation to compensate for the varying surface temperatures of the different zones of the turbine. For instance, on the high pressure shell, 10″ of cement was applied on the hottest (1050° F) and 7½″ on the coolest (800° F) sections.

An added advantage, for maintenance purposes, is that No. 1 may be removed from equipment where temperatures have not exceeded 1200° F and reapplied elsewhere. And a rust inhibitor prevents any corrosion of metal under the cement.

For more information on B-H No. 1 Insulating Cement and other B-H Insulations, write for Catalog or see it in Sweet's Plant Engineering File.

BALDWIN-HILL *Company*

CONTRACT APPLICATION SERVICE AVAILABLE

707 Breunig Ave., Trenton 2, N. J.

Kalamazoo, Mich. . . Huntington, Ind. . . Temple, Tex.

gum formation can destroy a gasoline's good name... protect yours with Tenamene

Eastman gasoline additives

When buying gasoline additives, keep these three points in mind:

One, Eastman offers you every principal type of gum inhibitor in commercial use today.

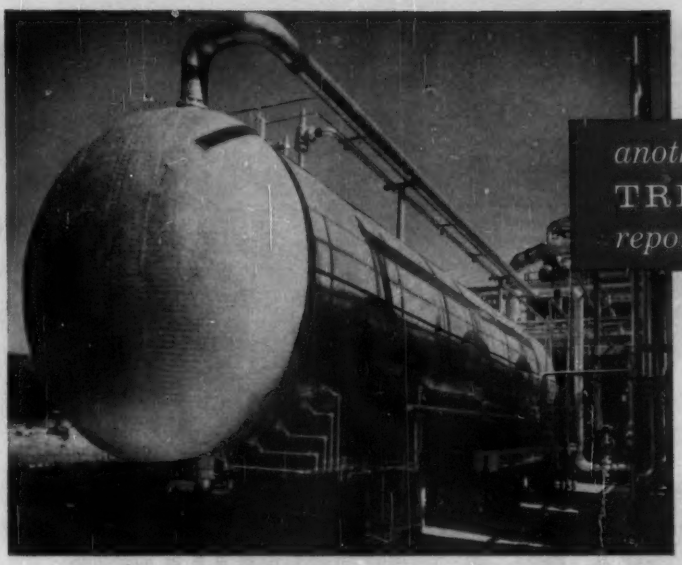
Two, Eastman, as a basic manufacturer of the additives it supplies, maintains complete control every step of the way, assuring you of a uniform product and consistent additive performance.

Three, Eastman petroleum specialists provide on-the-spot service to make sure you obtain the most efficient use of the additives you buy. Ask them about cutting costs through bulk delivery.

You'll find Eastman petroleum specialists can give you unequalled technical service because inhibition of gum formation is their only interest. EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tenn.; Atlanta; Chicago; Cincinnati; Cleveland; Detroit; Framingham, Massachusetts; Greensboro, N. C.; Houston; New York City; St. Louis. **West Coast: Wilson Meyer Co.,** San Francisco; Denver; Los Angeles; Phoenix; Salt Lake City; Seattle.

For more data on advertised products, use Readers' Service Cards, last page.



another
TRETOLITE SERVICE
report

OVER 1½ MILLION BARRELS OF CRUDE OIL ARE DESALTED EVERY DAY BY TRETOLITE DESALTERS

...average cost: $.0013 per barrel!

TRET-O-LITE* Chemical Desalters are in use in refineries throughout the world, reducing salt contents in the 95% to 100% range, at an average chemical cost of about 1.3 mills per barrel.

HOW TRET-O-LITE CHEMICAL DESALTING WORKS

TRET-O-LITE destabilizer is proportioned into the suction line of the crude charge pump to assure complete dispersion. Washwater (5% by volume of crude charge) is injected immediately following the charge pump. The oil, chemical and washwater mixture is raised to operating temperature, passed through an emulsifying valve, and then through a coalescing section to promote particle growth. The mixture then enters the desalting vessel which provides additional water-washing and settling time. The salt-free crude flows to the still and the saline effluent to the sewer.

*TRET-O-LITE *is a registered trade-mark of Petrolite Corporation*

TD 58-1R

4 CHOICES AVAILABLE

TRET-O-LITE Desalting is available to refiners through four different acquisition options:

1. **STANDARD PROPOSAL**—Construction by refiner according to plans and specifications furnished by Tretolite Company.
2. **STANDARD PROPOSAL WITH GUARANTEE**—As per standard proposal, but with desalting performance guaranteed. Engineering fee is charged when performance is guaranteed and acceptance tests are conducted.
3. **PURCHASE**—Tretolite Company delivers all desalting plant equipment for erection by refiner or his contractor.
4. **RENTAL, WITH OPTION TO PURCHASE**—Equipment furnished by Tretolite Company for erection by refiner or his contractor. Payment by predetermined annual rental fee.

With all of above plans, Tretolite engineers inspect during construction and supervise start-up and acceptance tests.

For complete information *ask the Man in the Red Car.* Or write to...

PETROLITE CORPORATION

TRETOLITE COMPANY DIVISIONS

365 Marshall Avenue, Saint Louis 19, Missouri
5615 Telegraph Road, Los Angeles 22, California

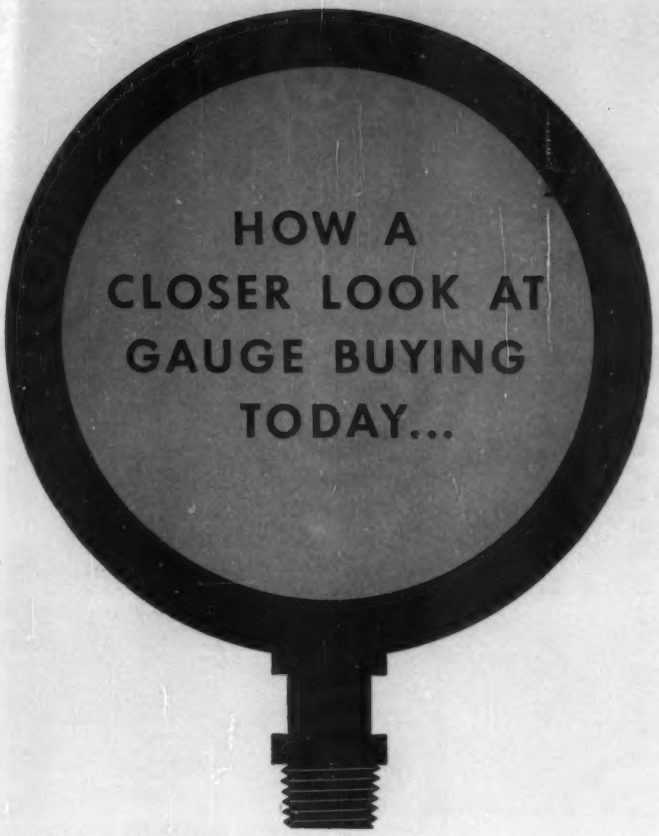
CANADA: Petrolite Corporation of Canada, Limited, 309 Alexandra Bldg., Edmonton, Alberta

ENGLAND: Petrolite Limited, Heathcoat House, 20, Savile Row, London W. 1.

VENEZUELA: South American Petrolite Corporation, Hotel Avila, Caracas

REPRESENTATIVES

BRAZIL: WERCO, Ltda., Avenida Rio Branco 57-s/1410-11, Rio de Janeiro
COLOMBIA: W. F. Faulkner, Calle 19, No. 7-30, Office 807, Bogota
GERMANY: H. Costenoble, Guiollettstrasse 47, Frankfort, a.M.
ITALY: NYMCO S.p.A. 9, Lungotevere A. da Brescia, Rome
JAPAN: Maruwa Bussan KK, No. 3, 2-Chome, Kyobashi, Chuo-Ku, Tokyo
KUWAIT: F. N. Dahdah, Box 1713, Al Kuwait
MEXICO: R. E. Power, Sierra de Mijes, No. 125, Mexico, D. F.
NETHERLANDS: F. E. C. Jenkins, Hoefbladlaan 134, The Hague
PERU: International Gas Lift Company, Apartado 71, Talara
TRINIDAD: Neal and Massy, Ltd., P.O. Box 544, Port of Spain



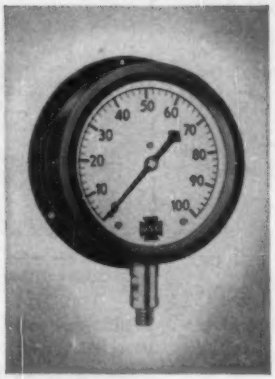
can give you a tighter grip on gauge costs!

Been looking at gauge buying in your plant as "routine"? In terms of gauge performance you need, accuracy you get, price you pay . . . and how and where you buy? You can pick up real savings with a closer look at your gauge requirements . . . and at what United States Gauge offers. USG features the world's largest stock of indicating dial pressure gauges. Over 50,000 standards, plus specials, with all possible choices of sizes, case stylings, pressure ranges and case materials . . . up to and including the finest gauges of highest accuracy. One source meets 99% of your pressure gauge needs, with the exact gauge for the exact purpose at the right price. And one phone call to your USG distributor taps that source. See the Yellow Pages, or write for catalogs and name of your nearest USG distributor today.

UNITED STATES GAUGE

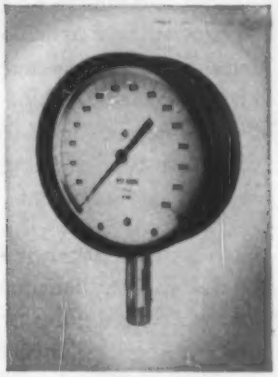
Division of American Machine and Metals, Inc., Sellersville, Pa.

Replacement costs too high? Volume-priced, precision-built USG drawn-case gauges are the money-savers for replacement of any A.S.A. Grade B gauge in your plant (accuracy of 2% guaranteed). These standbys are specified by more than 60% of original equipment manufacturers today. Proof of USG reliability and value! *Write for Catalog 64A.*

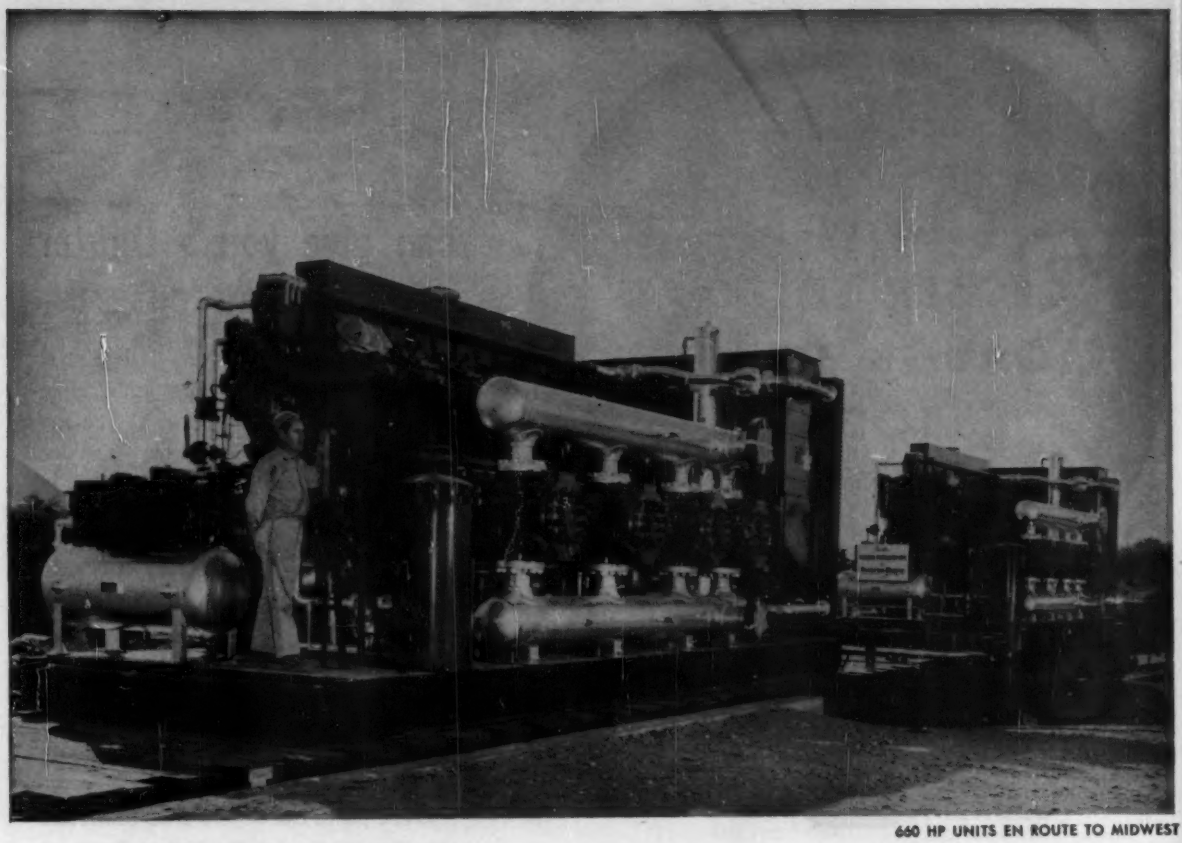


Paying a premium for quality design, reliability? Check the new USG A-Line, premium design at savings up to 40% of premium prices! Meets A.S.A. Grade A Standards, including accuracy of 1%. Wide range of cases, sizes, movements, pressures cuts *you* in on A-Line savings wherever you need dependable gauge performance. *Write for Catalog 305.*

Paying for performance you don't get? Look at the USG Supergauge® line. Built like a watch to A.S.A. specifications for Grade AA Test Gauges, these gauges pay for themselves in long-lived, dependable performance and lower maintenance costs. Accurate to 0.5% of scale range. Full selection of case styles, sizes and options. *Write for Catalog 1819.*



Losing out on highest accuracy? USG Test Gauges are the elite of the industry, equalling or exceeding A.S.A. Grade AA standards with accuracy as high as 0.2 of 1%! Styles, sizes and case materials for all types of laboratory and test uses. You can't buy higher quality and precision in a test gauge! Get your money's worth at USG. *Write for Catalog 400.*



660 HP UNITS EN ROUTE TO MIDWEST

"just like the BIG ONES"

Each Stearns-Roger Packaged Compressor Plant is engineered and built like a main-line compressor station, matched to present and anticipated field conditions as well as problems presented by each installation. Every unit gives you choice of compressor and auxiliary equipment, proven Stearns-Roger engineering and assembly, installation, initial operation and checking by Stearns-Roger service personnel, and prompt delivery.

Each plant is packaged for transport in one unit, by rail or highway, ready for connection and start-up immediately upon arrival. Where gases of any type must be compressed, these Stearns-Roger plants offer the lowest installed cost per horsepower.

WEST COAST INSTALLATION

Write for our brochure: Packaged Compressor Plants

Stearns-Roger

THE STEARNS-ROGER MFG. CO. • DENVER, COLORADO

DENVER • HOUSTON • EL PASO • SALT LAKE CITY
STEARNS-ROGER ENGINEERING COMPANY, LTD., *Calgary, Alberta*
ENGINEERS • CONSTRUCTORS • MANUFACTURERS

For more data on advertised products, use Readers' Service Cards, last page.

UNHARMED
by water... fumes... vibration
—the pipe insulation that's worth more money! You can't match UNIBESTOS for stamina. It was boiled in water for 72 hours to pass a recent certification test. Result: no opening-up of longitudinal or butt joints; almost complete absence of fraying; no mushing or falling away from pipe. 24 hours of drying restored initial characteristics without change in form or function. No other insulation is so *clean and easy* to cut—so *quick and simple* to apply—so *durable* in service. Temperatures to 1200°F. Sizes to 44" o.d. Single-Layer thicknesses to 5". Ask for Catalog F76-321 with exclusive "J" Factor Tables. Union Asbestos & Rubber Company General Sales Offices: 1111 W. Perry St., Bloomington, Illinois. Distributors in Principal Cities
UNARCO
UNIBESTOS®
the pipe insulation that's worth more money

Here's a vertical turbine with

TERRY SOLID WHEEL

and all its advantages

When it comes to judging a turbine's ability to deliver in vertical service, ratings tell only half the story. It's the Terry construction refinements that give you assurance of long-range operational economy: Thrust bearing designed to absorb external pump thrusts ... carbon ring glands specially made for vertical operation ... casings and bearing housings split vertically for easy accessibility.

But most important, the Terry vertical turbine has an *almost* indestructible rotor. A single forging of special composition steel, it has no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

If your application demands a vertical turbine, specify Terry solid wheel. Available in capacities from 5 to 300 horsepower. And remember, the extra durability built into these vertical turbines is typical of every turbine in the complete Terry line.

For further information, send for a copy of bulletin S-137.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

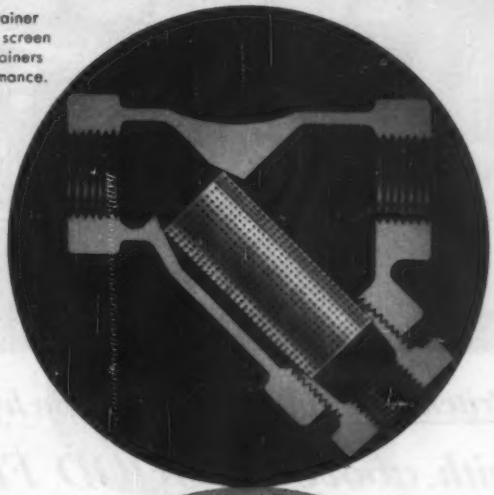
TT-1210

protect your equipment against scale and dirt

Exterior view of NEW Sarco Type "AT" Pipe Line Strainer. Note 45° blow-down angle to facilitate piping away from strainer.

with this

NEW SARCO TYPE "AT" PIPE LINE STRAINER



Cutaway of NEW Sarco Type "AT" Strainer shows sediment collection chamber below screen. Standard screen used in Sarco "AT" Strainers is key to their uniformly successful performance.

Examine one of the new Sarco Type "AT" Strainers and you'll notice at once that its design is a marked improvement over that of contemporary strainers... in three important ways:

The Sarco screen, key element of the unit, fits tightly into a long, tapered screen seat. This feature absolutely stops the by-passing of particles around the screen. Secondly, the rigid, welded construction of heavy-gauge brass makes sure the fit will remain tight, even when trapped sediment builds up pressure.

Third, you'll see that the new AT is easy to clean. No sharp edges or weave crevices in the screen for particles to cling to. Blow-down cleaning is simplified by the 45° angle construction.

Write for Sarco Bulletin No. 1210B which gives dimensions, capacities, and technical data. 7317-B

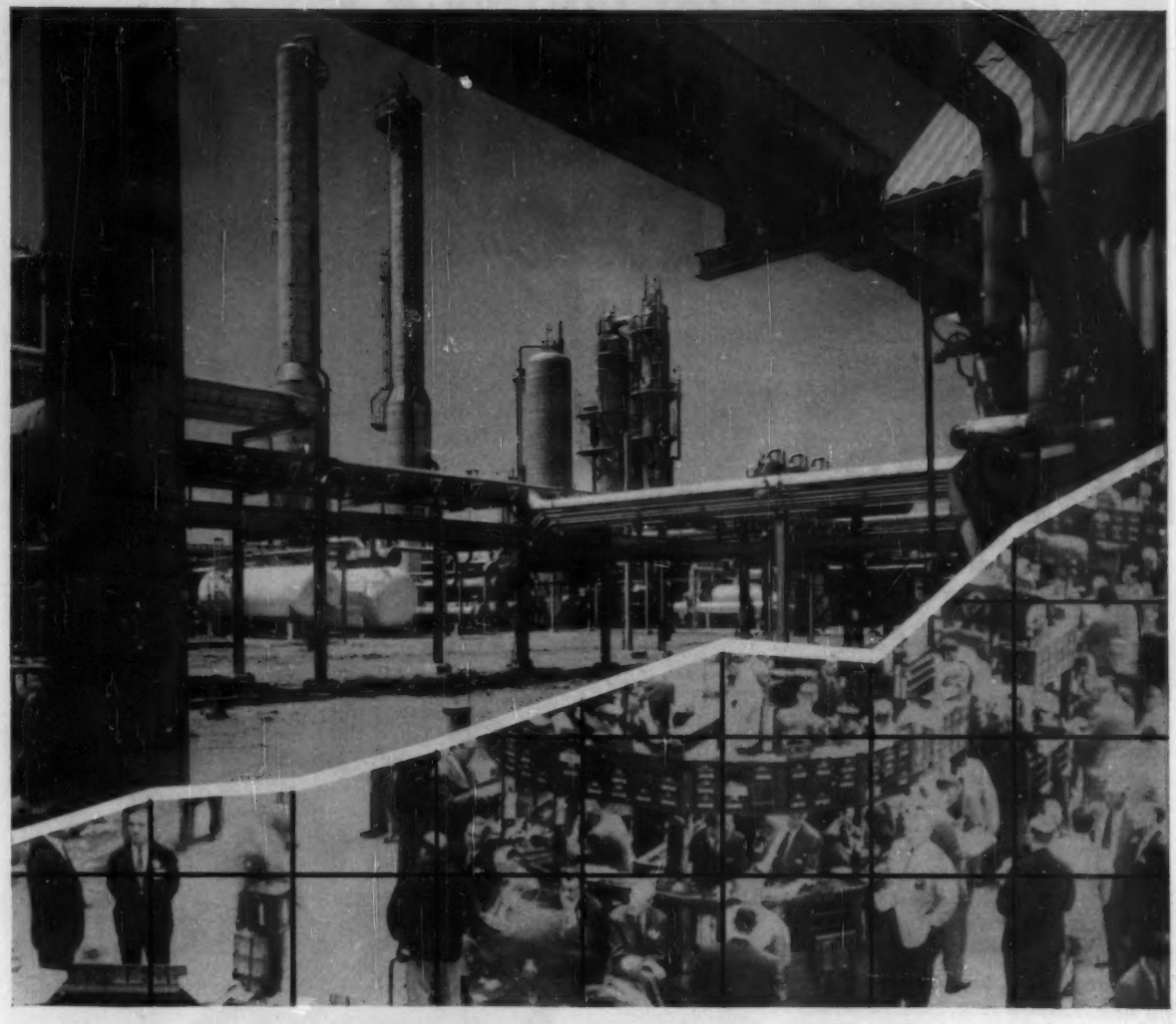
NOTE THIS ADDED PROTECTION AND CONVENIENCE

1. Bodies of heavy-duty 250 psi semi-steel. Tensile strength to 30,000 # per square inch minimum.
2. For maximum strength, bodies are reinforced with external rib.
3. Long, tapered screen seat assures correct screen position and tight fit without buckling.
4. Cap design provides a sediment collection chamber below screen.
5. Generous proportion of open screen area in relation to pipe size minimizes pressure drop.

SARCO
COMPANY, INC.
635 Madison Avenue, New York 22, N. Y.

STRAINERS • STEAM TRAPS • TEMPERATURE CONTROLLERS • HEATING SPECIALTIES

For more data on advertised products, use Readers' Service Cards, last page.



Pritchard's solution to volume hydrocarbon recovery...

with, above all, GOOD FINANCIAL DESIGN

One of the largest petro-chemical plants ever built – National Petro-Chemical Corporation's Tuscola plant–has changed an entire industry's thinking about hydrocarbon recovery. Designed and built by J. F. Pritchard & Company, Tuscola extracts ethane, propane and butane from natural gas using an oil absorption cycle in the extraction section shown above. The result: 50% more ethane per dollar invested than with low temperature condensation plants, and appreciably lower operating costs. Tuscola has set new profit potentials for the fuller utilization of natural gas.

Creative engineering as exemplified by Tuscola is only part of Pritchard's over-all approach to plant construction. Pritchard services – ranging from economic surveys to delivery of a turnkey job – all focus on one main consideration: good financial design. Engineering and construction are our long suits – but profitable, on-stream operation is the basis of our reputation.

If you are planning new construction in the gas, petroleum, petro-chemical or power fields, give us an opportunity to show you how good financial design can work for you.

PROFITABLE FACILITIES THROUGH GOOD FINANCIAL DESIGN

J.F. Pritchard & Co.

ENGINEERS • CONSTRUCTORS

Dept. 489, 4825 Roanoke Parkway, Kansas City 12, Mo.

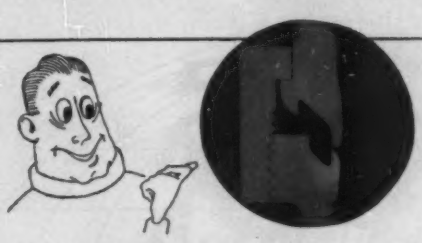
OFFICES IN CHICAGO, HOUSTON, PITTSBURGH, NEW YORK

SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES

For more data on advertised products, use Readers' Service Cards, last page.

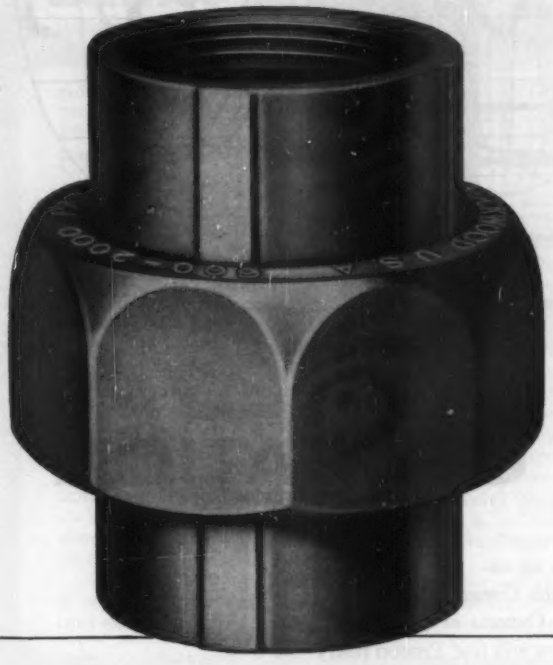
Rocky spots the advantages of color-coded Rockwood Unions

Color-coding makes identification easy for warehouse personnel and pipe fitters



Nut-Gray — 2 Silicon Bronze Seats (Type 601):
These seats prevent corrosive action, electrolytic action, and dezincification of seat joint. Silicon bronze withstands much higher temperatures than ordinary bronze or brass — *perfect for chemical, steel, rubber, paper, and textile industries.*

Nut-Black — 2 Stainless Steel Seats (Type 602):
For use with carbon steel pipe and where there are severe temperature or acid conditions — but where an all stainless steel installation isn't necessary.



Nut-Olive Drab — Moly Steel Seats (Type 603):
Provides Hardness Differential and offers extra strength and resistance against corrosion. Male seat specially heat treated for 150 Brinell greater hardness than female seat.

Nut-Gray — Moly to Silicon Bronze Seats (Type 604):
Combines advantages of Types 601 and 603. Specially adaptable for shipboard use.

You get all these advantages too—

All parts are completely interchangeable. Rockwood Cold Forged Steel Unions will not gall in "making up" because the male seat is 150 Brinell harder than the female seat. This is the Hardness Differential you *need* in replacement and new work.

Rockwood Unions meet all general piping requirements. They are highly corrosion-resistant and are sold off standard Black Steel price list. Packed in cartons for palletizing. All Unions are tested and listed by Underwriters' Laboratories, Inc. Write for complete information today.

ROCKWOOD SPRINKLER COMPANY

Distributors in all principal industrial areas

ROCKWOOD

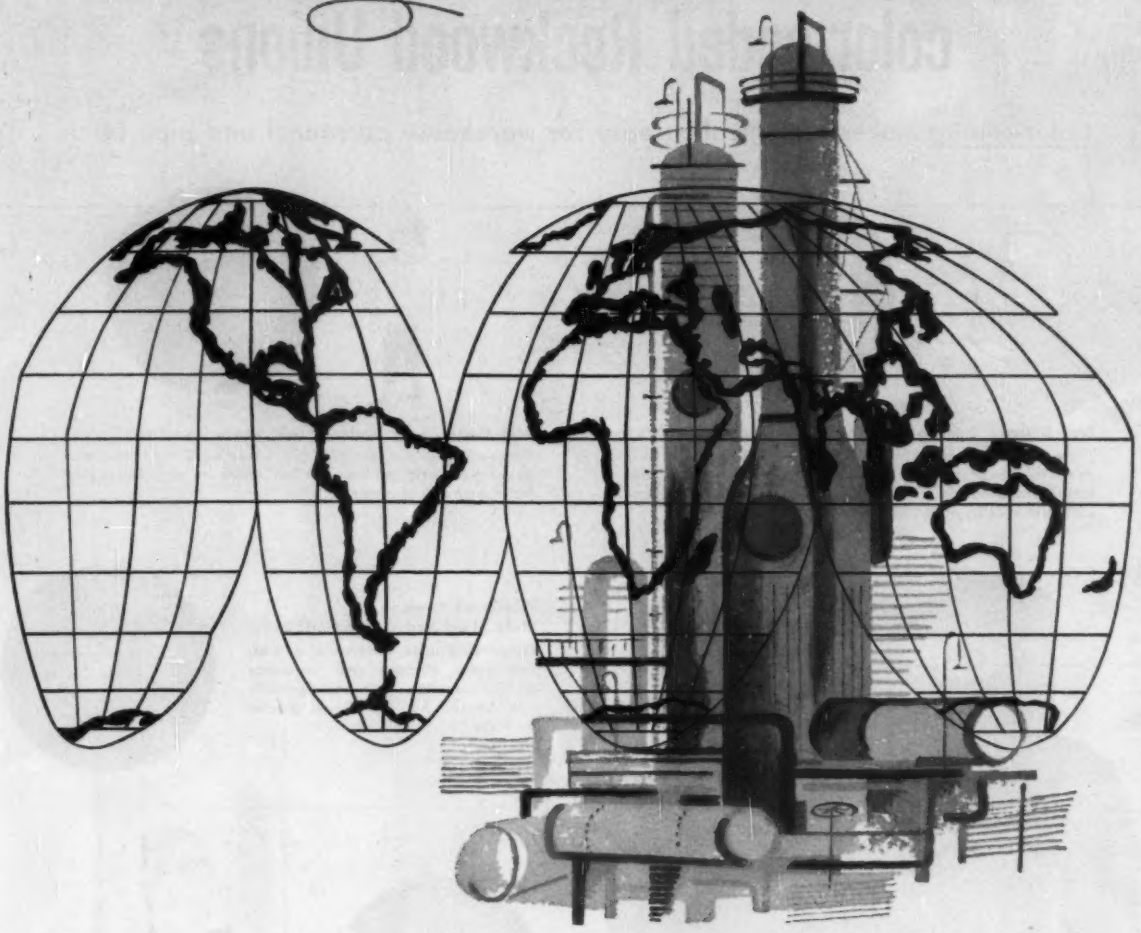
ROCKWOOD SPRINKLER COMPANY
721 Harlow Street
Worcester 5, Massachusetts

Please send me further information on Rockwood Unions.

Name.....
Title.....
Company.....
City.....
Zone.....*State*.....

For more data on advertised products, use Readers' Service Cards, last page.

intangibles were never so important



WORLD-WIDE OPERATION

A timely reminder that plant construction knows no national boundaries is the Fifth World Petroleum Congress. For wherever you plan to build . . . Canada or Cuba, Europe or the Middle East . . . you will find Procon ready and organized to handle your requirements in any part of the Free World. Skilled designers, engineers and construction crews can quickly be on the job building a petroleum, petrochemical or chemical plant or processing unit as required. And you may be sure it will be built to your satisfaction . . . to precise specifications and on time!

WE INVITE YOU TO VISIT US AT BOOTH 643 IN THE NEW YORK COLISEUM, MAY 30 THROUGH JUNE 5.

PROCON®

PROCON *Incorporated*

1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U.S.A.

PROCON (CANADA) LIMITED, TORONTO 18, ONTARIO, CANADA

PROCON (GREAT BRITAIN) LIMITED, LONDON, W. C. 2, ENGLAND

PROCON INTERNATIONAL S. A., SANTIAGO DE CUBA

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

New AN AUTOMATIC, COMPACT **LimiTorque**

...FOR OPERATING YOUR

Plug Valves

...IN 8 TO 16 SECONDS

LimiTorque LINEAR MOTORIZED VALVE OPERATOR

...a dependable time, labor and money saver

Another LimiTorque *first* — here's the answer to the problem of motorizing your wrench (hand) operated Plug Valves . . . a simple, easily installed unit that can be built either to NEMA IV (weather-proof), or NEMA VII (explosion-proof) standards . . . an inexpensive, sturdy, fully reliable and extremely compact assembly that requires no gear changes or modifications, other than to supply a motor with the proper output speed. The *LimiTorque Linear Operator* consists of motor and double reduction gearing which drive a traveling screw and a crank that is easily mounted to the square shank of plug valve.

As noted in the illustrations, the entire assembly can be readily adapted to your plug valve while in service, by merely mounting the crank on the plug shank and strapping the support bracket to the pipe . . . The *Linear Operator* is supplied with all necessary adapting parts such as the support bracket and straps for mounting on the pipeline; also the necessary crank arm for mounting on the square shank of valve plug — The entire construction and operation is indeed simple . . . and the purchase price and installation costs are comparatively low.

A torque of 175# is developed at the valve, which is normally more than enough to drive most wrench-operated plug valves up to 6" in size. If power fails, or manual operation is desired, the mere removal of a pin (which connects the traveling screw to the crank arm) will divorce the crank from the *Linear Operator* assembly — and a bar placed in the bushed bore of the crank arm will operate the valve. (No special wrench is needed.) The mere flick of a switch to the direction of travel desired will operate the valve . . . Contact your valve manufacturer, or your nearest LimiTorque Sales Engineering Office.

Full details on this *new LimiTorque Linear Operator* are contained in Bulletin 20-58 . . . send for copy on your business letterhead.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

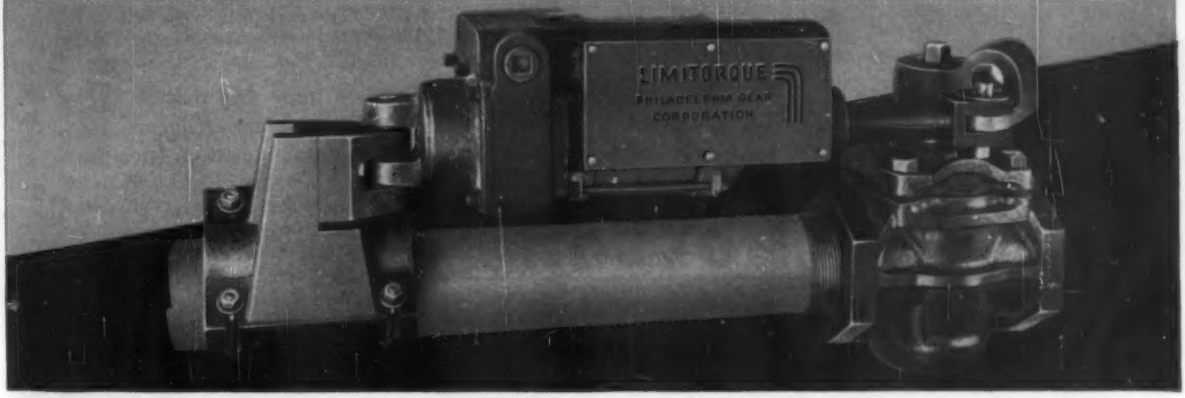
PHILADELPHIA GEAR CORPORATION

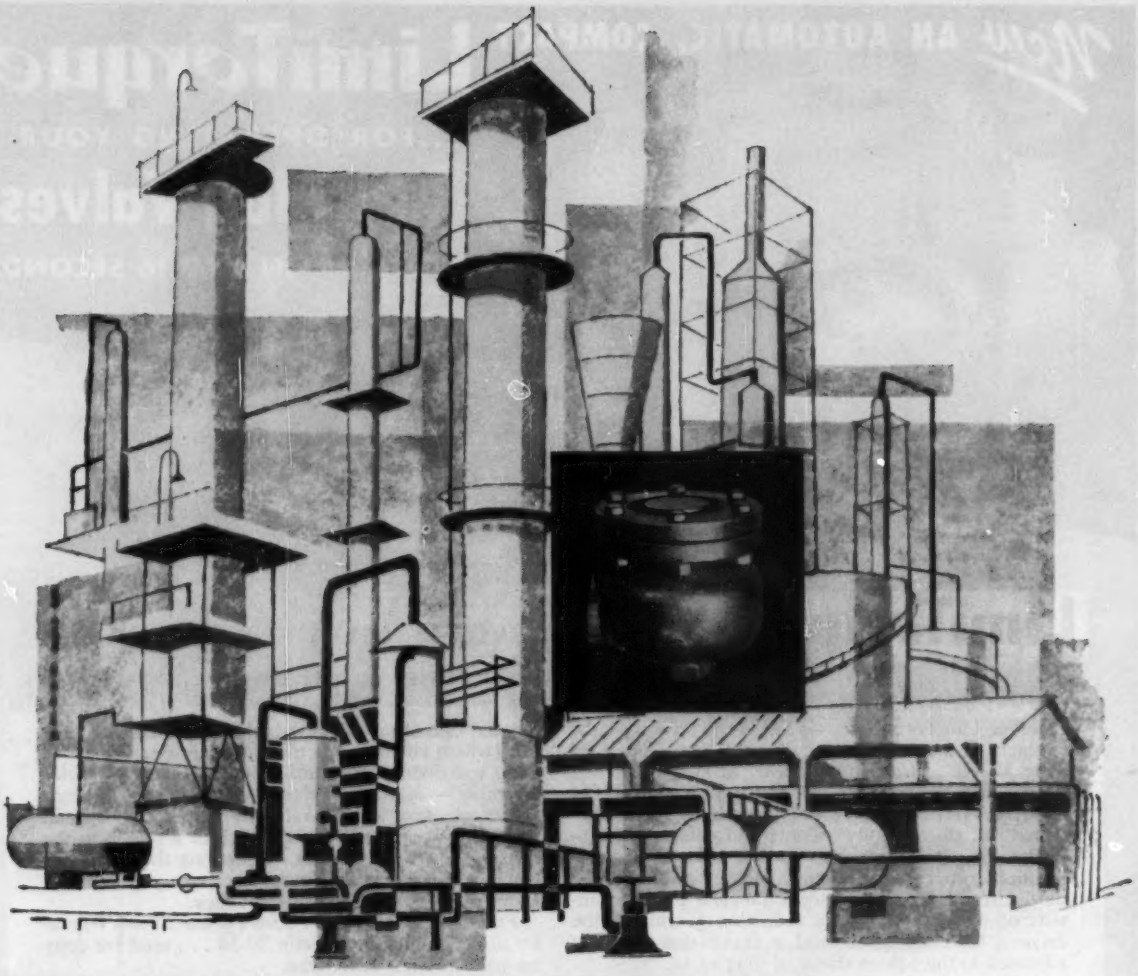
ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS
LIMITORQUE VALVE CONTROLS
FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia





THE ECONOMICS OF STEAM TRAP SELECTION

Initial cost versus installed cost

Everybody wants to save money in the purchase of steam traps, or anything else.

But a wise buyer will recognize that the *real cost* relates to the entire useful life of his plant, and that selection of the most efficient trap for a given application is an important consideration.

Compare the efficiency of Nicholson traps with that of so-called "bargains" and you'll see why plant engineers responsible for successful operation usually insist on Nicholson.

ST-102

NICHOLSON

OF WILKES-BARRE

W. H. Nicholson and Co. • 14 Oregon Street • Wilkes-Barre, Pa.

Distributors in all principal cities

You'll never have to nurse this O_2 Analyzer

What are your most serious complaints about O_2 analyzers? Cumbersome? Slow? Unstable? Hard to service on the job?

You won't find these potential trouble-sources in our new Unitized O_2 Gas Analyzer. They've been literally "designed out" by L&N engineers with experience totaling millions of man-hours in industrial gas analysis.

The Unitized O_2 Analyzer is reduced to the essentials consistent with highly efficient O_2 measurement and control. The entire analysis is made within the 2-component team of O_2 Analyzer Assembly and Speedomax® recorder, eliminating unwieldy auxiliary components such as sample conditioners. Due to its direct magnetic operation, the equipment employs neither auxiliary gas supplies, chemical reactions, nor combustion. Sample and calibration controls are accessible externally, without disturbing the measuring system.

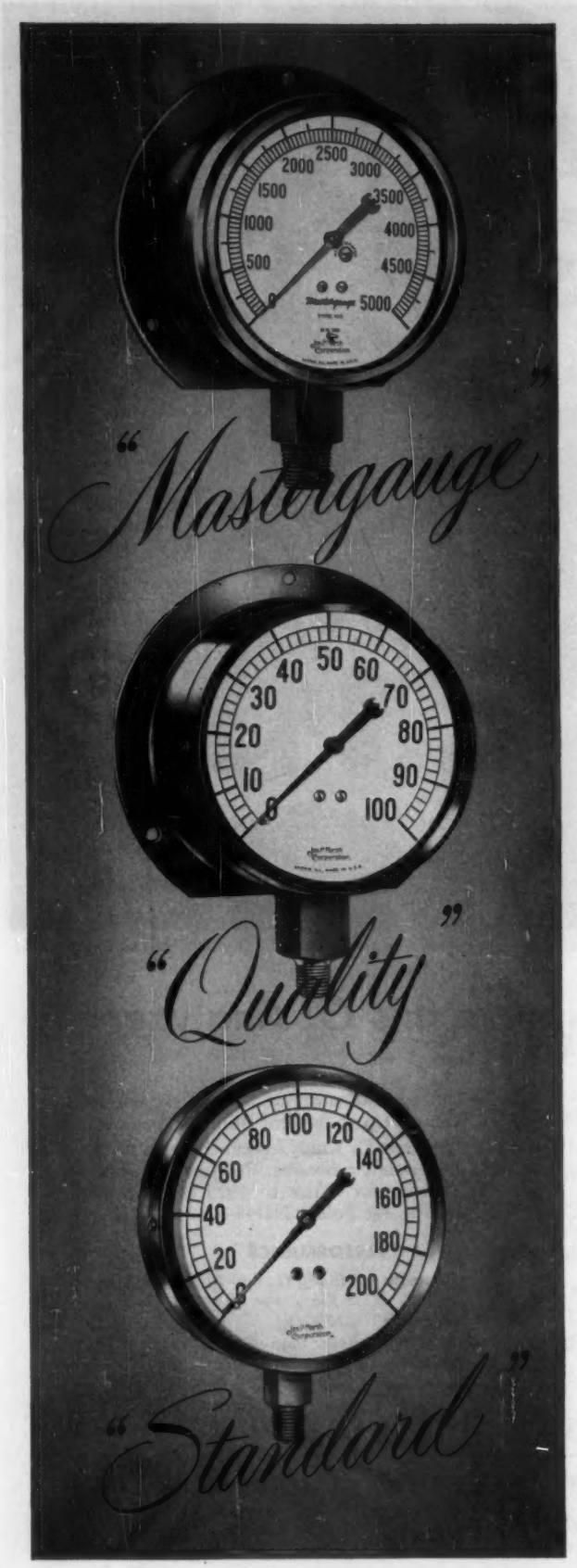
We've introduced sampling innovations, too. The Analyzer gets a sample not only cleaned but purified. A typical sampling lag is 1 sec per 45 ft of ¼" tubing, up to several hundred feet.

The Unitized O_2 Analyzer can help to streamline O_2-dependent processes. For pertinent details of this O_2 monitor, write to 4923 Stenton Ave., Phila. 44, Pa., for Folder ND46-91(5).

PERFORMANCE

Range	*0 to 5% O_2, 0 to 10% O_2, or higher in flue gas or N_2 as specified.*
Accuracy	*0.15% O_2*
Sensitivity	*Better than ±0.05% O_2*
Stability	*Better than ±0.15% O_2*
Response	*4 sec for initial response; 40 sec for 90% response.*

LEEDS NORTHRUP
instruments automatic controls • furnaces



What pressure gauge for your particular need?

The clear-cut economical answer to your specific gauge problem is right here in the Marsh line. It is here because the Marsh line contains the world's most complete range of gauges in the three broad brackets of gauge applications.

THE "MASTERGAUGE" GROUP...for those extreme services that demand the ultimate in gauge precision, accuracy and stamina.

THE "QUALITY" GROUP...also for tough conditions, but less severe than the conditions served by the "Mastergauge" Group.

THE "STANDARD" GROUP...for the general run of pressure gauge services.

While these three brackets run a wide gamut of prices, the difference between them is not so much a matter of *grade* as a matter of *kind* and *purpose*. All gauges in all groups reflect Marsh precision and quality. Collectively they cover practically every conceivable gauge requirement.

The answer is in the catalog...but if you have a special problem let our engineering department work with you to select the most efficient, most economical solution to your problem.

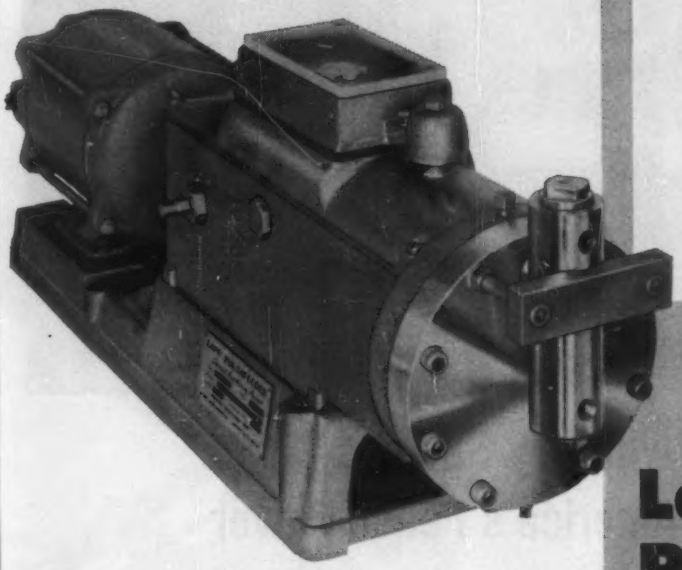
MARSH INSTRUMENT CO.
Sales Affiliate of Jas. P. Marsh Corp.
Dept R, Skokie, Illinois.
Marsh Instrument & Valve Co., (Canada) Ltd.,
8407 103rd St., Edmonton, Alberta, Canada.
Houston Branch Plant, 1121 Rothwell St.,
Sect. 15, Houston, Texas

MARSH

"THE STANDARD OF ACCURACY"

For more data on advertised products, use Readers' Service Cards, last page.

These fluids are difficult to meter...



FORMALDEHYDE
MERCURY
MOLTEN METALS
SULFUR DIOXIDE
HYDROBROMIC ACID
SULFURIC ACID
HYDROCHLORIC ACID
LIQUID BROMINE
LIQUID CHLORINE
FLUORINE GAS
HYDROFLUORIC ACID
HYDROGEN FLUORIDE
SULFUR DICHLORIDE

They are handled successfully by the

Lapp PULSAFEEDER

CONTROLLED-VOLUME CHEMICAL PUMP

The Lapp Pulsafeeder is a highly-specialized, precision pump suited to a wide variety of special applications involving controlled-volume pumping of fluids. It's a combination piston-diaphragm pump having a hydraulically balanced diaphragm and a closed hydraulic system. The reciprocating piston action provides accuracy of positive displacement while the diaphragm isolates liquid being pumped from the pump's working parts. Eliminates need for stuffing box or running seal . . . prevents product leakage and contamination. Pumping speed is constant, variable flow results from variation in piston-stroke length . . . controlled manually by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable. Pulsafeeder capacities range from 585 ML per hour up to 24 gpm maximum flow and pressures from minus atmospheric to 6800 psig.

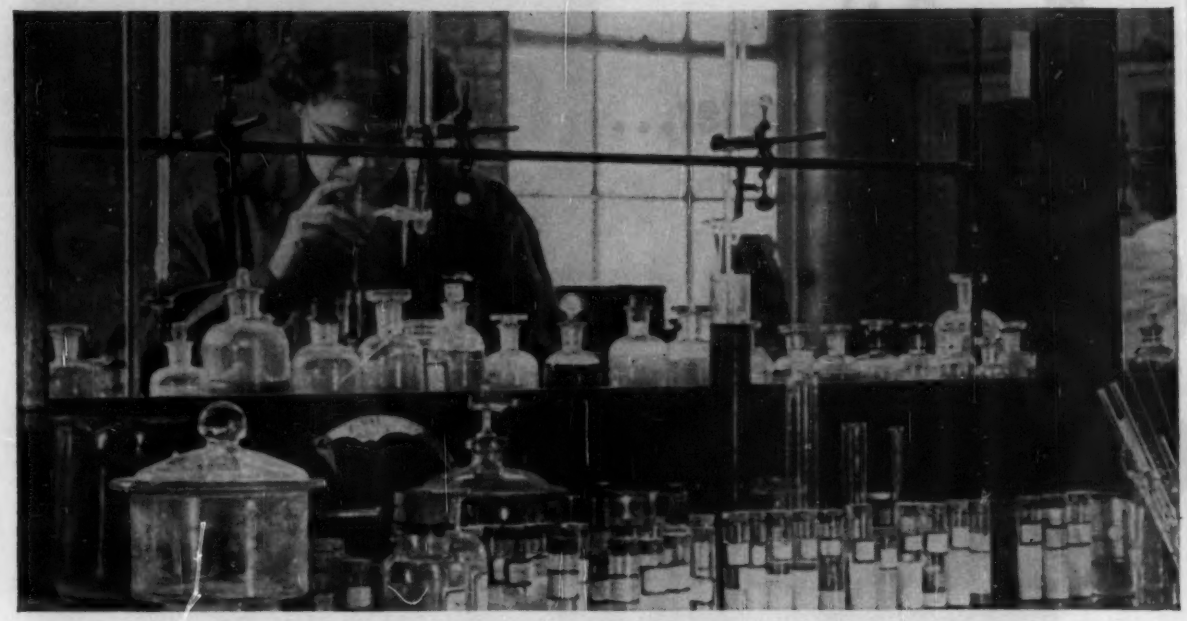
Specify Lapp Pulsafeeder when you need continuous (or intermittent) pumping, at accurately controlled volume, of fluids which cannot be satisfactorily exposed to conventional pistons, cylinders and stuffing box packing. Or because of the corrosive action of chemicals and/or the need for protection of product against contamination.

Lapp

WRITE FOR BULLETIN 440 containing typical applications, flow charts, description and specifications of models of various capacities and constructions. Lapp Insulator Co., Inc., Process Equipment Division, 3408 Poplar Street, Le Roy, New York.

For more data on advertised products, use Readers' Service Cards, last page.

THE U. S. TREASURY SALUTES THE CHEMICAL INDUSTRY



—and its people who buy Savings Bonds and strengthen America's Peace Power

Every family and every industry in this country benefit, directly and indirectly, from the work of our great chemical industry. Those whose lifework is in chemistry may well take pride in the vast good that stems from their profession. Thousands upon thousands of people in the chemical field are proud, too, of their share in America's Peace Power, for they are making regular purchases of U.S. Savings Bonds.

Buying Shares in America through the Payroll Savings Plan is a convenient and systematic way to practice thrift. It helps these patriotic people enhance their resources for home building, for education and for greater security after retirement.

If your company has not yet installed a Payroll Savings Plan, start at once. The easy first step is to telephone your State Savings Bond Director for the help he will give you, gladly. Or write to Savings Bonds Division, U.S. Treasury Department, Washington 25, D. C.

JAMES C. VICKERS is pictured here practicing his highly specialized skills in one of our country's great chemical plants. Mr. Vickers is typical of the thousands of expert workers in this field who are buying U.S. Savings Bonds regularly. Mr. Vickers uses his company Payroll Savings Plan to make regular contributions to the Peace Power of his country.

Petroleum Refiner

THE U. S. GOVERNMENT DOES NOT PAY FOR THIS ADVERTISEMENT. THE TREASURY DEPARTMENT THANKS, FOR THEIR PATRIOTISM, THE ADVERTISING COUNCIL AND THE DONOR ABOVE.

Stainless Steel beats high temperature sulfide corrosion

AT GULF OIL'S
PORT ARTHUR, TEXAS, REFINERY

These atmospheric and vacuum distillation units, until just recently, processed about 32,000 barrels of West Texas sour crude per day. The atmospheric tower, barely visible in the right background, fractionates the crude to produce wet gas, straight run gasoline, light naphtha, light and heavy furnace oil, atmospheric gas oil and reduced crude. The vacuum tower in the center fractionates the reduced crude into light and heavy vacuum gas oil and bottoms.

Stainless Steel is the most practical material to withstand high temperature sulfide corrosion in the lining of these units. Operating temperature in the bottom shell of the atmospheric tower is 600° F. and in the vacuum tower it's 680° F. The ¼" Type 405 Stainless Steel lining in the vacuum tower has been in service for ten years, and it hasn't shown one sign of failure! The atmospheric tower was not originally designed with Stainless and later was found to be corroding so badly that a Type 410 Stainless Steel lining was installed in the lower part of the tower.

It pays to design with the right material from the start. If you need corrosion resistance and strength at high temperatures, there is no material that can match the performance and economy of Stainless Steel. Order USS Stainless Steel through your U. S. Steel representative or your local Steel Service Center.

USS is a registered trademark

United States Steel Corporation—Pittsburgh
American Steel & Wire—Cleveland
National Tube—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

USS United States Steel

NEW TAYLOR ELECTRO-PNEUMATIC VALVE POSITIONER

Couples advanced electronic control with smooth pneumatic action

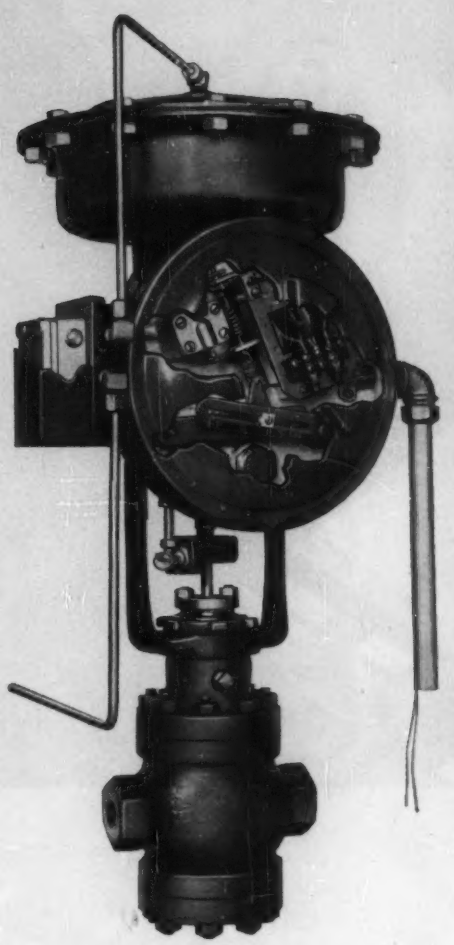
A skillful combination of new and proven design features, the Taylor 713R Valve Positioner converts an electrical milliampere input from the controller into a pneumatic force *insuring positive positioning of the valve actuator proportional to the electrical input.* It permits full utilization of the desirable characteristics of electronic control, coupled with the power and smooth throttling action of pneumatic valve actuators.

The 713R has unmatched stability, due to a powerful, balanced armature that reduces the effects of shock and vibration to a minimum. It is designed for use in hazardous areas designated for Class I, Group D, Division I equipment.

CHECK THESE FEATURES

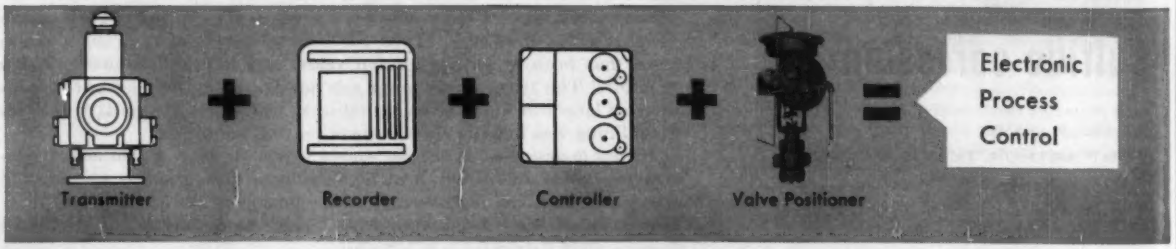
1. **High threshold sensitivity**—made possible by compact, powerful torque motor which positions stainless baffle with respect to stainless nozzle.
2. **Faster operating**—due to high capacity leakless booster relay.
3. **Wide supply pressure range**—operates with air supply pressure between 20 and 50 psi.
4. **Economy of installation and operation**—designed for use on regular plant air.
5. **Easy, safe servicing**—externally-mounted booster relay can be removed without breaking the electrical circuit, and without affecting its protection in hazardous areas.
6. **Standard input ranges**—1 to 5 ma, 4 to 20 ma, and 10 to 50 ma dc signal.
7. **Great adaptability**—same basic positioner can be applied to *reverse* or *direct* actuators, *reverse* or *direct* valve bodies, and other makes of actuators.

See your Taylor Field Engineer, or write for **Bulletin No. 98334.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ontario.



Taylor Electro-pneumatic Valve Positioner mounted on new Taylor LIN-E-AIRE® Valve Actuator.

®Trade-Mark



Taylor Instruments **MEAN ACCURACY FIRST**

KEY-KAST® Long Tangent Elbows provide uniform strength

KEY-KAST *Long Tangent* Welding Elbows will give you outstanding service in any high pressure, high temperature alloy piping system. They are the *only* long tangent elbows with cast steel walls of uniform thickness and strength. Nipples and extra welding are eliminated — long tangents can be provided at either or both ends.

Quality controlled through the most rigid metallurgical standards, Key-Kast Elbows meet ASTM specifications, and ASME and ASA code requirements.

Call your Key-Kast representative for prompt, experienced service in selecting the Key-Kast *Long Tangent* Elbow best for you. Available in all standard sizes and schedules with tangent lengths as long as half the O.D. of the connecting pipe . . . and specially designed to meet specific conditions of pressure, temperature and lading. *W-K-M Division of ACF Industries, Incorporated, P. O. Box 2117, Houston, Texas.*

Key-Kast Fittings can handle any piping job. Specify them. You'll get outstanding service.

W-K-M

SERVING INDUSTRY 40 YEARS

Uniform Wall Elbows

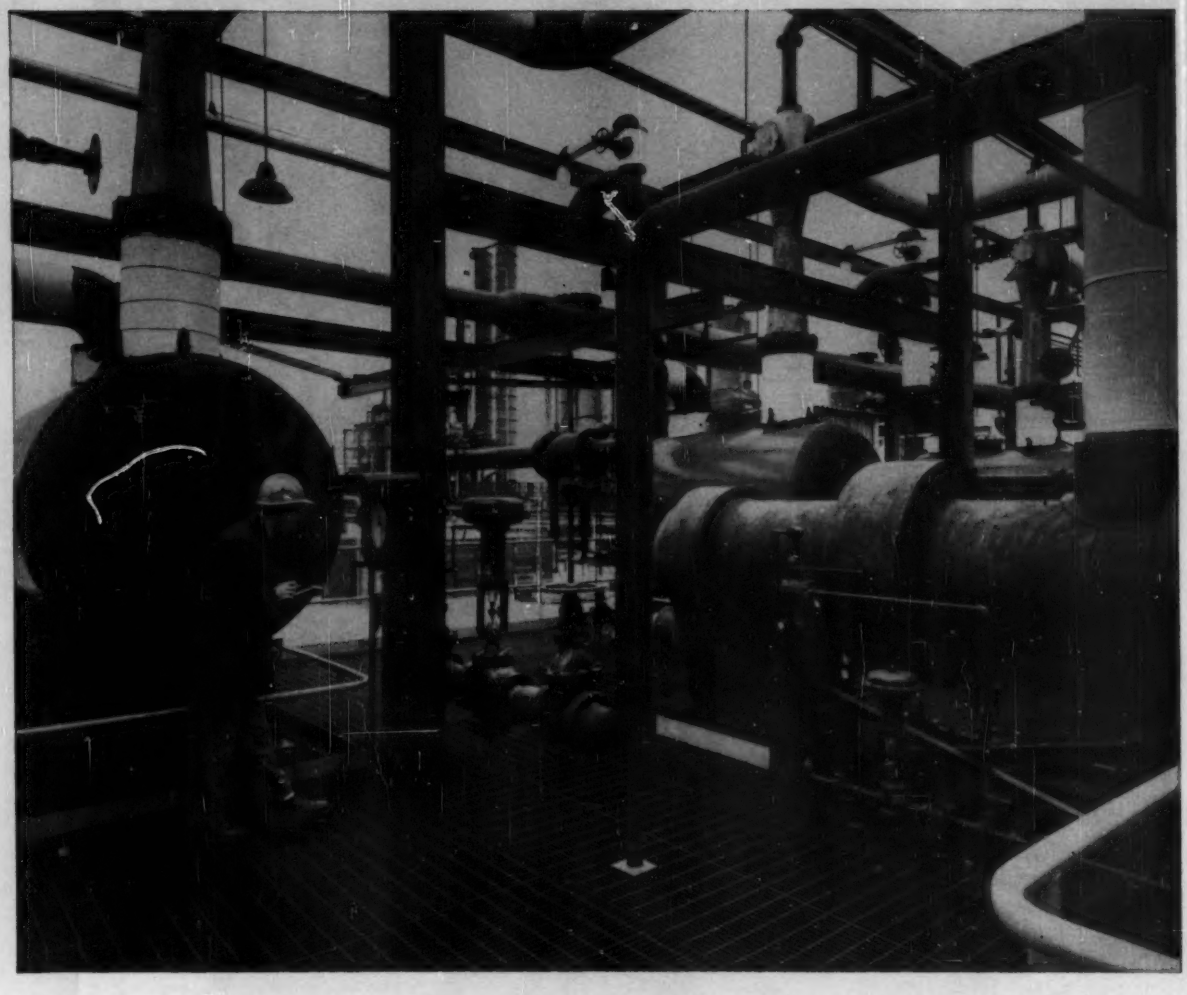
Key-Kast **Long Tangent** Elbows have uniform cast steel walls approximately 15% heavier than the required minimum thickness of pipe walls of the same I.D. For extra highly stressed line sections, the wall thickness can be increased as much as desired — without sacrificing uniformity.

The flexibility of Key-Kast Elbows permits their use in piping systems based on the usual piping stress calculations. Write for engineering bulletin entitled "Key-Kast Welding Elbows in Piping Stress Calculations," for W-K-M's Quality Control Specifications No. 102958 (conventional steam power) and No. 103058 (nuclear power).

Products of W-K-M's

Creative Engineering

5903



Where Corrosion is a problem...

Specify BLAW-KNOX Electroforged® Grating and Treads

For maximum service in corrosive environments, Blaw-Knox Electroforges grating of the world's finest corrosion resistant metals. Monel, Cor-ten, stainless steel, and aluminum, proven throughout industry, Electroforge into rigid, one-piece grating to withstand the most corrosive conditions.

Electroforging crossbars to bearing bars eliminates crevices and joints where corrosion usually starts. Rigid, one-piece construction cuts to fit neatly around beams, pipes, and other installations.

For safe walking in any weather, Blaw-Knox grating features the twisted crossbar, and choice of two types of bearing bars, square, or serrated. For conventional uses specify Electroforged steel grating, galvanized or painted.

For information on how to specify the Blaw-Knox Electroforged Grating and Treads to solve your problem, write for Blaw-Knox Bulletin 2527-R.

BLAW-KNOX

BLAW-KNOX COMPANY

Blaw-Knox Equipment Division
Dept. D, Pittsburgh 38, Pennsylvania

For more data on advertised products, use Readers' Service Cards, last page.

S&J 2006

EASIEST TO READ— MOST ACCURATE GAGE EVER!

2006 contains these gagers "most wanted" features:

Large, white numbers on black for maximum visibility and accurate readings. Teflon bearings for minimum friction, greater gaging accuracy. Superior quality components, precision machining, clean, modern design for dependability and service. Rugged construction, minimum maintenance. Simple, fast adjustment. Easy attachment of transmitters for remote reading systems. These are some of the exclusive S&J features that make 2006 a major achievement in tank gages. Write for details today.

SHAND AND JURS — GENERAL PRECISION EQUIPMENT CORPORATION GPE

SHAND AND JURS COMPANY 2600 Eighth Street, Berkeley 10, California

A Subsidiary of General Precision Equipment Corporation

Branch offices and representatives in principal cities

4825

• *Working with you and your contractor—*

1 SOURCE OF SUPPLY
1 RESPONSIBILITY

for all this chemical and petroleum equipment

Through the integrated facilities of YUBA—NATIONWIDE to serve you best

The problem of coordinating all the purchases and delivery of specialized equipment for chemical, petroleum and petrochemical plants can be greatly simplified—when it is packaged as a single responsibility with Yuba.

The advantages to you, your consultants and your contractor are many. The experienced Yuba organization is geared to deliver a fully integrated service every step of the way: through equipment design, engineering, manufacturing, installation and erection.

Operating nationwide, Yuba plants are ideally equipped and located to maintain the highest product quality standards and meet the most demanding completion dates—economically.

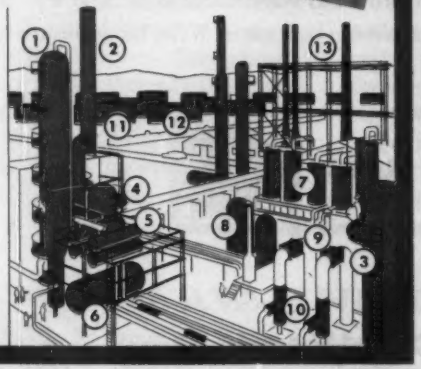
Call in your Yuba man. Discuss your plans and problems with him. See how your job can be made easier with his and Yuba's help.

DIVISIONS AND SUBSIDIARIES SERVING THE CHEMICAL AND PETROLEUM INDUSTRIES: Yuba Heat Transfer Division • Adsco Division • Yuba Manufacturing Division • Southwest Welding & Manufacturing Division • Judson Pacific-Murphy Division • Yuba Consolidated Erectors, Inc.

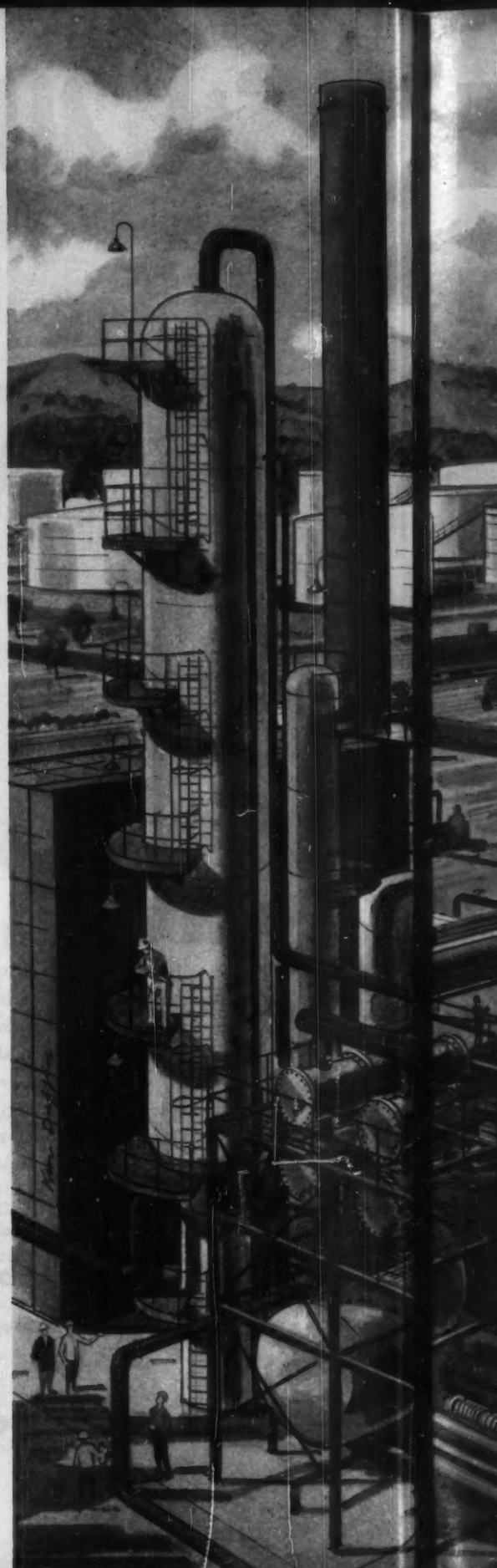
Write for free copy of new Yuba Bulletin 858-PR for full details.

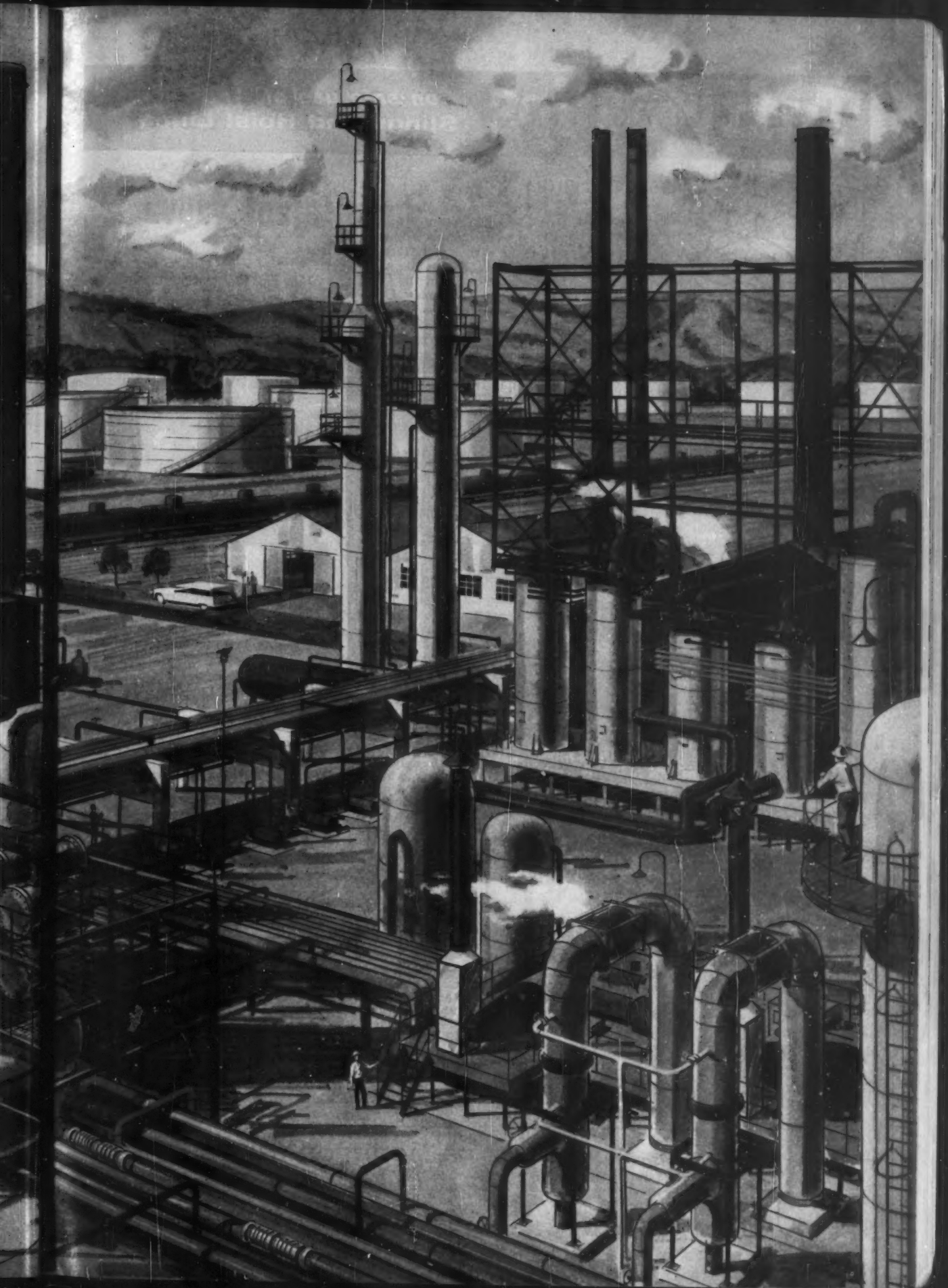
YUBA PRODUCTS FOR THE CHEMICAL AND PETROLEUM INDUSTRIES

1. Columns
2. Stacks
3. Ladders & platforms
4. Scrubbers
5. Heat exchangers
6. Pressure vessels
7. Reactors
8. Storage bins
9. Expansion joints
10. Condensers
11. Cone roof tanks
12. Floating roof tanks
13. Structural steel

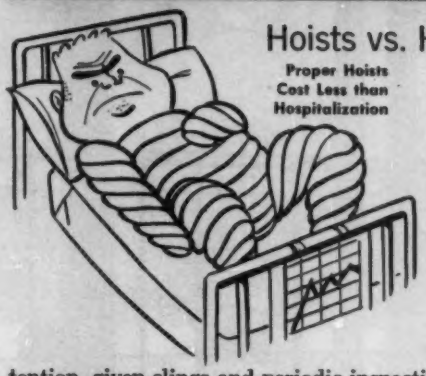


YUBA CONSOLIDATED INDUSTRIES, INC.
351 California Street, San Francisco, California





Tuffy Tips —on safe use of Slings and Hoist Lines



Hoists vs. Hernia

Proper Hoists Cost Less than Hospitalization

A manufacturer said recently that 75% of his compensation claims were connected with hernia—a common hazard in heavy lifting. About the same time, we heard from the Ohio Bureau of Workmen's Compensation that the average hernia claim (circa 1957) was $750. No need to stress the need for hoists instead of muscle for lifting tasks. Said "Occupational Hazards" magazine: (Hoists) with proper attention, given slings and periodic inspections, will help substantially in reducing back injuries and hernia claims by reducing the strain on workers."

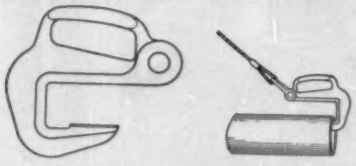
A Few Rules for Safe Use of Hoists and Slings

1. Use a proper size hoist—not human backs and muscles—for every heavy lifting job.
2. Never use load chains as slings. Chain links break easily after distortion.
3. Use the sling that's right for the job. There's a Tuffy Sling for every purpose.
4. When loading slings with more than 2 legs: load a 3-legged sling as though it had 2½ legs; load a 4-legged sling as though it had 3 legs.

Proper Fittings Give Slings Added Safety and Service Life

Union offers a sling fitting for every need. We recommend having them factory-fitted when you order your slings, but they can also be fitted in your own rigging loft. Shown here are two of a score of different fittings used on Tuffy Slings.

NEWCO STANDARD CHOKER HOOK: Standard in design, but extra high in quality and safety. Castings are always smooth and clean. No cutting or chafing slings. This hook can be attached to the end of sling instead of the main body, thus allowing the main part of the sling to be free of fittings.



NEWCO PIPE HOOK: Precisely "tailored" to the job of moving and laying pipe. High strength steel. Capacity of 3500 lbs. Pad at end allows threaded pipe to be handled without damage to threads. Eye opening is large enough to accommodate a shackle or thimble. Hook has a lifting handle for easy moving.

Made for Each Other: Tuffy Slings and Hoist Lines

Tuffy Slings and Hoist Lines make a top-performing team for every kind of hoisting work. Tuffy Slings are made of a patented, 9-part machine-braided wire fabric that's extra flexible, and isn't materially damaged by knotting or kinking. Tuffy Hoist Line is a special rope construction for use on all types of overhead cranes, derricks and clamshells—and wherever else an extra-quality, extra safe hoist line is needed. Reports from the field tell of Tuffy Hoist Lines running two and three times as long as ropes previously used.

Tuffy Kink-Resistance is Unmatched

Kinking is one of the worst hazards of wire rope and sling use. With ordinary wire rope slings, an acute kink results in serious damage and weakening that makes the rope unsafe for further use. With Tuffy, it's a different story. The super-flexible fabric is just about impossible to kink. If it does under exceptional conditions, the kink can be easily straightened out with no harm done.

Safest Ferrule Ever Made

The pressed-on steel ferrule is applied under great pressure. The ferrule metal virtually flows into voids between wires and strands of the fabric. Result: an eye splice with 100% of fabric strength, and a ferrule so smoothly tapered to the sling body that there are no abrupt edges or rough projections to snag or injure hands. And the extra service life, efficiency and safety of Tuffy's pressed-on ferrule are yours at no extra cost.

FREE! New Tuffy Sling Handbook

Revised and enlarged edition. Covers all the bases in selection and use of Tuffy Slings and fittings. Gives types, dimensions and rated loads. Includes safety-approved hand and whistle signals in operation of various equipment. Send for your copy now. **Write Union Wire Rope Corporation, 2284 Manchester Ave., Kansas City 26, Mo.**

Specialists in high-carbon wire, rope, braided wire fabric and stress relieved wire and strand.

Your Tuffy Distributor is Ready to Help You with any Sling or Wire Rope Problem

UNION Wire Rope

S-4

Subsidiary of **ARMCO STEEL CORPORATION**

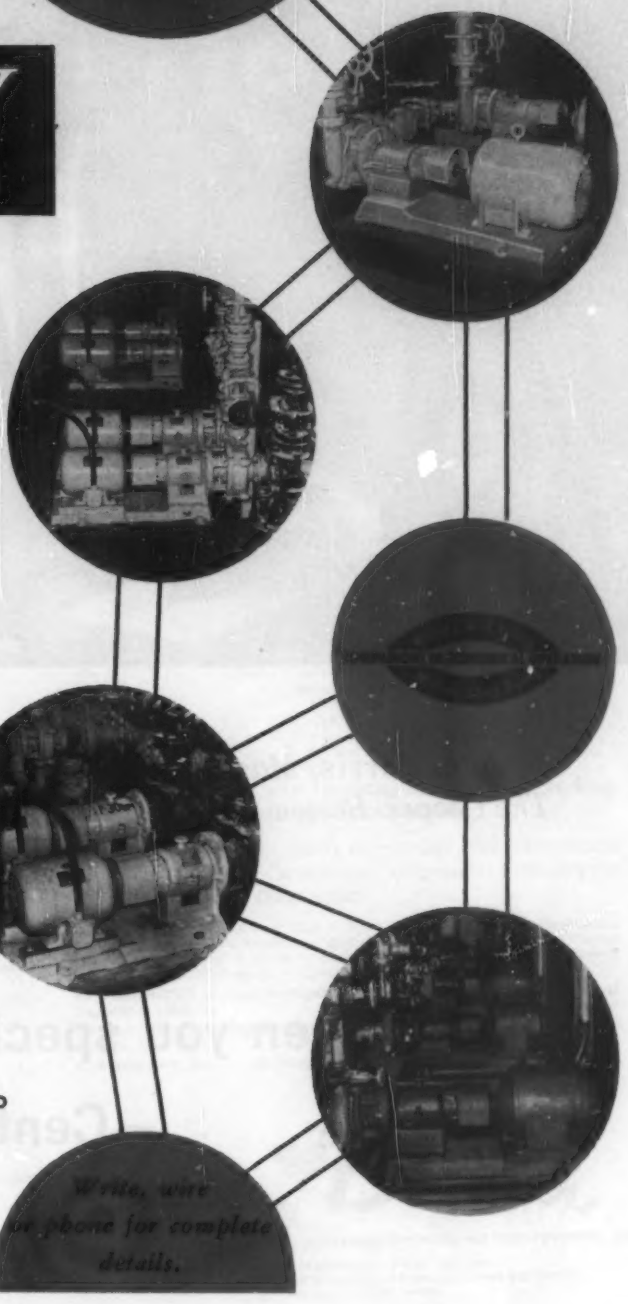
OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company
Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Southwest Steel Products

New steels are born at Armco

Every Installation

JOB ENGINEERED for Maximum Pumping Economy

WILFLEY
ACID PUMPS



Individual engineering on every application is standard practice with Wilfley. This personal attention to your specific requirements, plus Wilfley's day-in, day-out dependability, guarantee low cost pumping. Put a Wilfley Acid Pump to work... it will give you continuous, trouble free service, higher output and longer pump life.

Wilfley Acid Pumps are available with pumping parts of machinable alloys as well as plastic to meet every need in the handling of corrosives, hot liquids and other difficult solutions.

A. R. WILFLEY and SONS, INC.

DENVER, COLORADO, U.S.A., P. O. BOX 2330

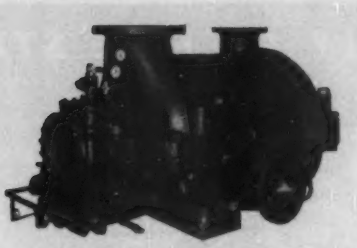
NEW YORK OFFICE:
122 EAST 42ND ST., N.Y. CITY 17

Write, wire or phone for complete details.

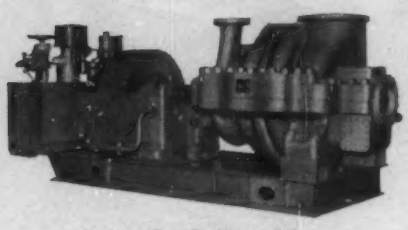
For more data on advertised products, use Readers' Service Cards, last page.

John L. Parris, *Manager Centrifugal Compressor Sales, The Cooper-Bessemer Corporation, explains...*

How you gain four ways when you specify Cooper-Bessemer Centrifugal Compressors



Horizontally split, process air or gas centrifugal compressor. Range: Up to 100,000 cfm.



Horizontally split, intercooled centrifugal compressor designed for low cost shop and process air and gas. Up to 30,000 cfm.

Pipeline centrifugal booster with a history of record-breaking performance. Up to 20,000 bhp.

Installations can be integrated with Cooper-Bessemer En-Tronic Controls all the way from simple monitoring to complete system automation.

Barrel type centrifugal compressor for gas and air at pressures up to 5000 psi.

To get the most for your compressor dollars, it will pay you to check into Cooper-Bessemer Centrifugal Compressors because these fully-proved products offer you a combination of four outstanding advantages:

1. You get a design that's matched to your needs. A wide range of types and sizes of Cooper-Bessemer Centrifugal Compressors are available to assure optimum performance on *your* processing or air supply application.

2. You get unsurpassed quality. The designs include many field-proven distinctive features. Cooper-Bessemer's high standards of materials and craftsmanship are applied to every component of these precision-built units... to assure utmost reliability.

3. You can get undivided responsibility. We can engineer the entire compressor installation, including drive and controls. Cooper-Bessemer En-Tronic Controls are available to provide any degree of automation.

4. You get service for most profitable performance. Our outstanding field service and warehouse facilities assure prompt attention to your operating needs... with resulting reduction in your inventory and downtime.

Our nearest office will gladly supply complete information on Cooper-Bessemer Centrifugal Compressors to meet your needs exactly. Call them today.

BRANCH OFFICES: Grove City • New York • Chicago • Washington
San Francisco • Los Angeles • Houston • Dallas • Odessa • Pampa
Greggton • Seattle • Tulsa • St. Louis • Kansas City • Minneapolis
New Orleans • Shreveport • Casper

SUBSIDIARIES: Cooper-Bessemer of Canada, Ltd.... Edmonton • Calgary
Toronto • Halifax

Cooper-Bessemer International Corporation ... New York • Caracas
Mexico City

C-B Southern, Inc.... Houston

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS • DIESEL • GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL,
ENGINE OR MOTOR DRIVEN

SERIES 60—normal needs, pressures to 400 psi, 6 sizes. **SERIES 120**—normal needs, pressures to 600 psi, 6 sizes. **SERIES 40**—for extra heavy loads, 5 sizes. **NO. 30**—for extra light loads (½" only). **INTEGRAL STRAINER**—highest pressures and marine use, 6 sizes.

NEW NO. 30 IS A LIGHT LOAD SPECIALIST

When the condensate load in your steam lines is *extra light*—this new Yarway ½" No. 30 Steam Trap is *exactly right.*

Specify it. You'll experience new *economy of operation* with the *tighter shut-off.* Operation is *quieter* due to lever action. *Maintenance is less*—because of the replaceable valve-seat assembly, only one moving part and stainless steel construction. Enjoy these special features plus all the regular advantages of famous Yarway Impulse Traps such as *quick heating, even temperatures, small size, good for all pressures, non-freezing.*

Over 1,250,000 Yarway Impulse Traps already sold; buy yours from one of 270 local Industrial Distributors.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.

YARWAY *impulse® steam traps*

For more data on advertised products, use Readers' Service Cards, last page.

Are you responsible for the critical piping in your plant?

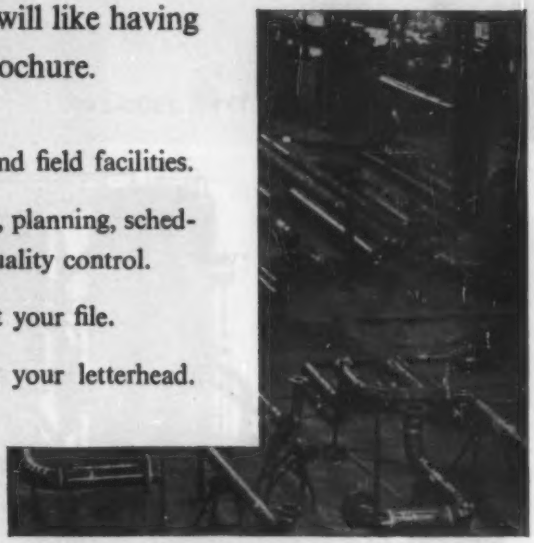
If you know the wisdom of delegating the prefabricating and erecting of high-temperature, high-pressure piping directly to experienced specialists, you will like having a copy of our illustrated Brochure.

It's an exposition of our shop and field facilities.

It covers equipment, engineering, planning, scheduling, testing, inspecting, and quality control.

It is only four pages, sized to fit your file.

Ask us for "the Brochure" on your letterhead.



W. K. MITCHELL & CO., INC.
Philadelphia 46, Pa.

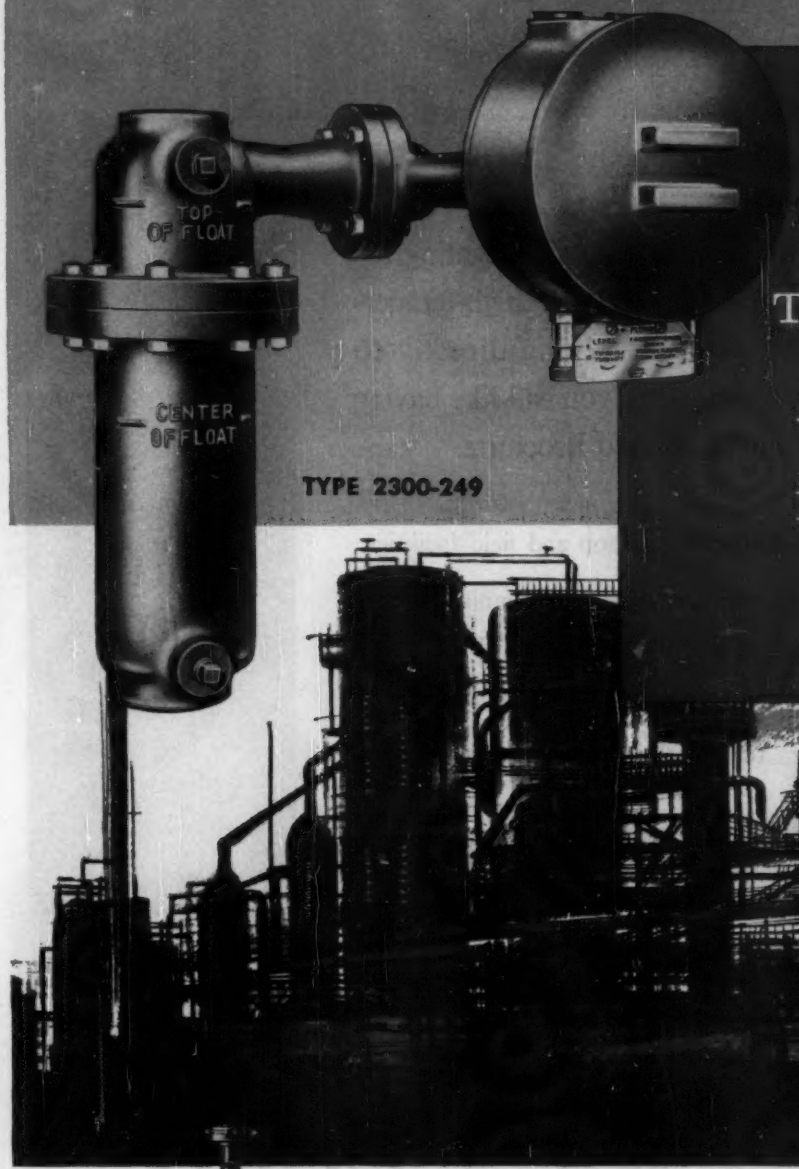
WESTPORT JOINT
(PATENTED)

MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS

For more data on advertised products, use Readers' Service Cards, last page.

Choose Electronic or But Choose the



THE CONTROLLERS THAT HANDLE ALL YOUR LIQUID LEVEL PROBLEMS

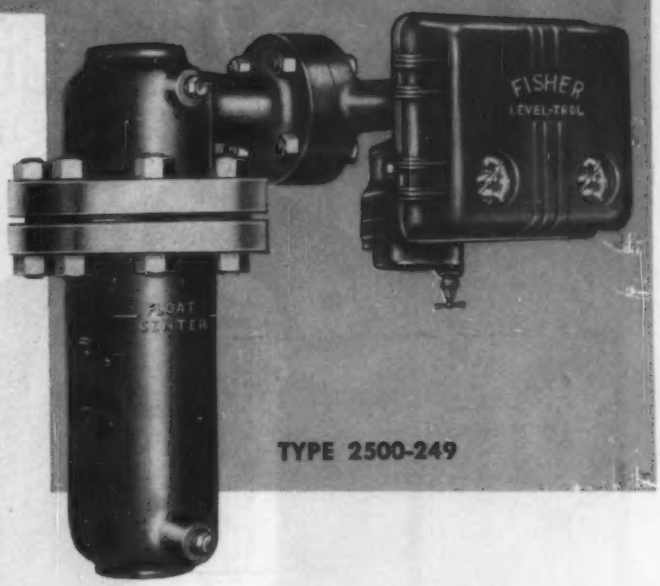
IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

Choose Pneumatic
FISHER LEVEL-TROL®

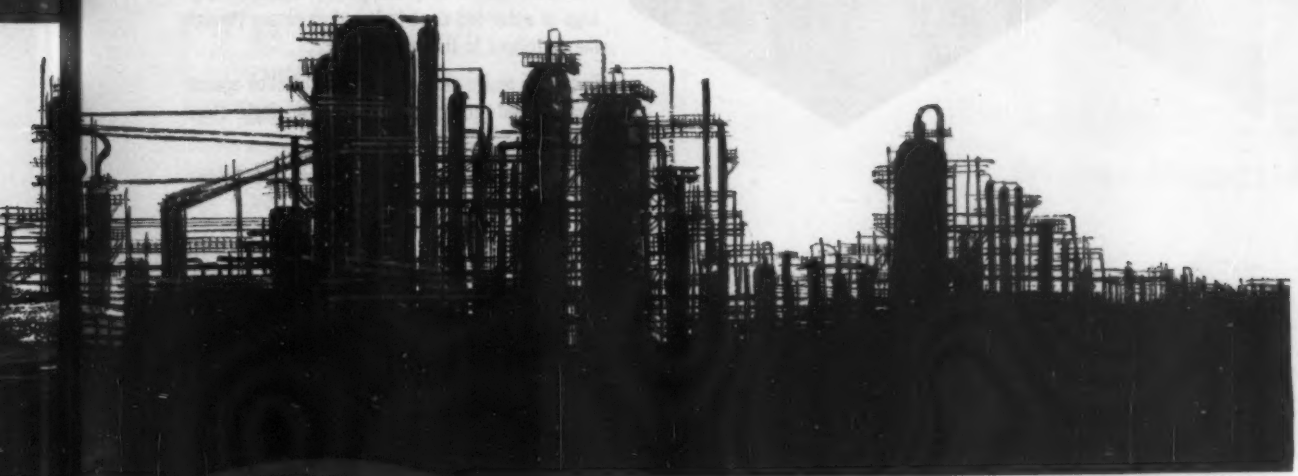
Using essentially the same displacement float assembly and other components that have made the Level-Trol so popular in the process industries, Fisher can now provide the Level-Trol with either a pneumatic or an electronic pilot. The same style of Level-Trol mounting and displacement floats in sizes up to 120" can be supplied for either pilot.

Type 2300-249 Electronic Level-Trol: Explosion-proof design and external adjustments for proportional band and liquid level set point make the Fisher Electronic Level-Trol ideal for use in hazardous locations. Delivers a proportional 1 to 5 milliampere dc signal through 3000 ohm load. Has plug-in converter with printed circuit.

Type 2500-249 Level-Trol: Highly flexible! Can be pneumatically operated with a wide variety of pilots. Handles practically any liquid level, interface level or specific gravity control or indication problem.



TYPE 2500-249



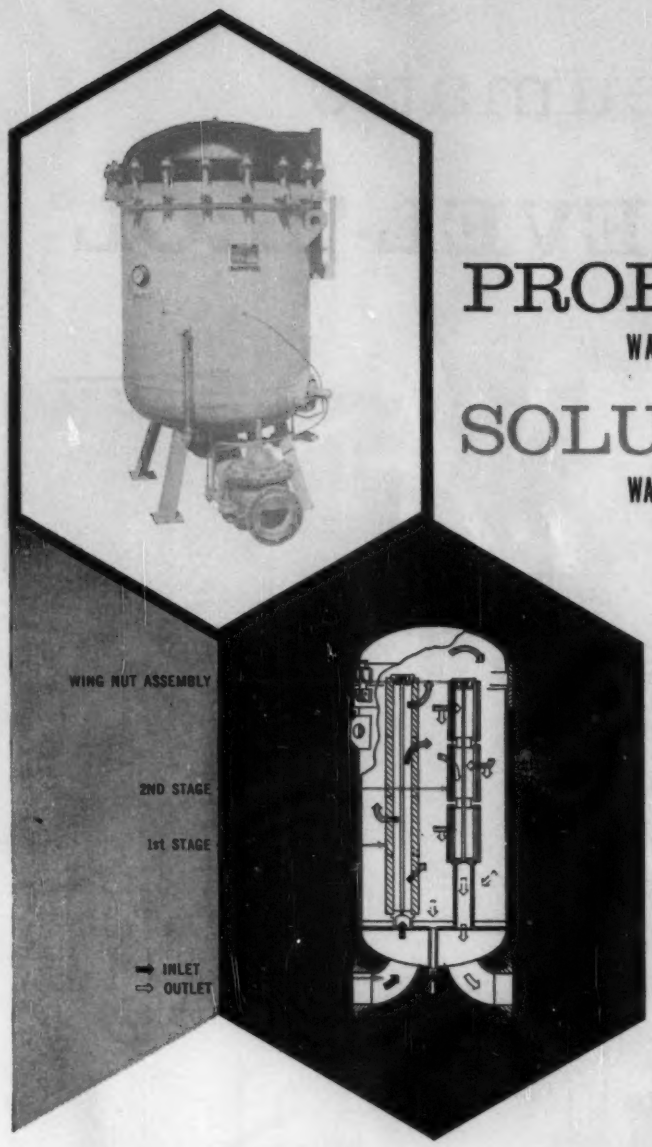
FISHER® Controls

SINCE 1880

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

BUTTERFLY VALVE DIVISION: CONTINENTAL EQUIPMENT CO., CORAOPOLIS, PENNSYLVANIA



PROBLEM:

WATER AND DIRT IN PETROLEUM PRODUCTS

SOLUTION:

WARNER LEWIS TWO STAGE SEPARATOR/FILTERS

For Process, Pipeline and Marketing Facilities

HOW IT WORKS

1st Stage — Coalescing-Filtering

Hydrocarbon and water enter inlet and pass through the coalescer cartridges where solids such as dirt, rust and scale are removed and mechanical emulsions are broken. Finely dispersed water droplets gather together into large water droplets and fall by gravity into the water-collecting sump.

2nd Stage — Separating

Clean hydrocarbon and any entrained water droplets flow to the separator cartridges. This chemically-treated media completely blocks the passage of water and clean hydrocarbon passes through the cartridges to the outlet.

Two stage design provides positive protection against contaminated products not possible in single stage designs.

Replacement cartridges feature high dirt holding capacity and low cost replacement.

Write Process Section, Warner Lewis Company, for details.

WARNER LEWIS COMPANY

BOX 3096 • TULSA, OKLAHOMA

DIVISION OF FRAM CORPORATION

AMOCO CHEMICALS—A NEW RESOURCE

Five AMOCO Additive Product Bulletins to help you

Here are five informative bulletins that give technical data helpful in evaluating AMOCO Additives. Bulletins document with test data and comparative illustrations, the performance of motor oils and gasolines containing AMOCO Additives. Typical physical and chemical properties of the additives are included. Technical service by experienced petroleum additive engineers, to assist you in the use of AMOCO Additives, is also available.

AMOCO 193 INHIBITOR
Gives information on this multi-functional zinc dithiophosphate motor oil additive which inhibits oil oxidation, protects bearings from corrosion, and prevents excessive wear of critical engine parts.

AMOCO 200 SERIES DETERGENT-INHIBITOR ADDITIVES
Data are given on the use of a number of the outstanding detergent-inhibitor additives of this series in making motor oils. All are combinations of Amoco's unique barium detergent and zinc dialkyl dithiophosphate inhibitor.

AMOCO 600 VISCOSITY INDEX IMPROVER
Contains data on how AMOCO 600 VI Improver helps provide easier starting, increased gasoline mileage, less ORI, greater shear stability, better oil mileage. Useful blending chart included.

AMOCO 520 SERIES METAL DEACTIVATORS
Information is provided on extending storage life of copper-contaminated gasoline stocks, heating oils and diesel fuel with metal deactivators of this series.

AMOCO 530 SERIES GASOLINE ANTIOXIDANTS
Each of the three major chemical types of gasoline antioxidants, for economical protection from gum formation, are included in the AMOCO 530 Series. Here are data on all of them.

PRODUCT BULLETIN
AMOCO CHEMICALS CORPORATION
AMOCO 193 Inhibitor
A Dialkyl
Zinc Dithiophosphate
PRODUCT BULLETIN
AMOCO CHEMICALS CORPORATION
AMOCO 200 Series
Detergent-Inhibitor
Additives
PRODUCT BULLETIN
AMOCO CHEMICALS CORPORATION
AMOCO 600
Viscosity-Index Improver
A Linear Isobutylene Polyme
PRODUCT BULLE
AMOCO CHEMICALS CORPORATION
AMOCO 520 Seri
Metal Deactivat
PRODUCT BULLETIN
AMOCO CHEMICALS CORPORATION
AMOCO 530 Series
Antioxidants
The most economical and effective protection from gum formation is available in the AMOCO 530 series antioxidants. The group consists of four products — AMOCO 531, 532, 533, 534 — and includes each of the major chemical types of gasoline antioxidants. From this AMOCO series, it is possible to select the proper treatment for each gasoline blend. Early addition to unstable streams saves antioxidant.
AMOCO 531 Antioxidant
N-Butyl-p-aminophenol in isopropanol
AMOCO 532 Antioxidant

AMOCO CHEMICALS CORPORATION
910 S. Michigan Avenue, Chicago 80, Illinois

Announcing a n

a new "Partnership"...

to serve you better, faster!

EFFECTIVE IMMEDIATELY: JONES & LAUGHLIN SUPPLY DIVISION WILL DISTRIBUTE

OIC VALVES

Here are the most advanced valve designs for today's petroleum industry.

OIC has served the petroleum industry for over a half century. Their management has always emphasized improved valve design, rigid quality control and thorough product testing.

OIC produces a complete line of bronze, iron, forged steel, cast steel and ductile iron valves. They are available for prompt delivery from any one of J&L's 75 conveniently located supply stores in the United States.

To further assure prompt delivery, store inventories are backed up by factory stocks at key points. The talents and resources of both companies are at your service to satisfy your every valve requirement.

We're out to serve you better than you've ever been served before. Just try us.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

If it's sold by J&L....
It's the best available

Interested in "cutting" time?

... Then get a RIDGID for faster, cleaner cuts on every job!

For General Use buy

RIDGID

Heavy-Duty Pipe Cutters

Factory tested for perfect tracking, here's your best cutter buy for hand use. Extra-long shank protects threads, gives fast, easy adjustment. Large handle for sure grip . . . more leverage. Strong, special malleable frame won't bend or warp. You'll also need the RIDGID Wide-Roll Cutter, that tracks perfectly at high power-drive speeds, and the RIDGID 4-Wheel Cutters, that give quick, clean cuts in tight places with only quarter turns.

Five Sizes for ⅛" to 6"

For Tubing and Thin-Wall Conduit buy

RIDGID

Tubing Cutters

Five Sizes for ⅛" to 4"

Exclusive fold-in reamer on Nos. 10, 15 and 20 protects hands and pockets . . . reams full cutter capacity. Thin-blade wheel gives quick, clean cuts. Rollers smooth tubing ready for soldering. Special RIDGID No. 315 3-Wheel Cutter gives fast cuts in hard-to-get-at places.

There's a RIDGID Cutter to save you time on every job. Call your Supply House today!

RIDGID

The Ridge Tool Company • Elyria, Ohio, U.S.A.

Your

STRUCTURAL STEEL and STEEL PLATE FABRICATION

ON TIME!

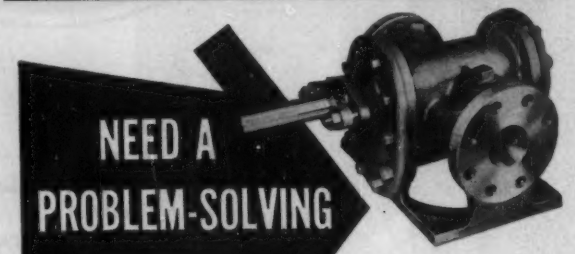
We pride ourselves for "on time" delivery. Thoroughly experienced staff of designers, engineers, and fabricators, to furnish the steel you want, when you want it. AISC members. ASME pressure vessels, tanks, heat exchangers, as well as structural steel. Location served by SP and MP railroads, and our dock is on the Intracoastal Waterway. Write, wire or phone for FACT FILE on our complete facilities.

ST. MARY IRON WORKS, INC.

Steel Fabricators for over Half a Century

FRANKLIN, LOUISIANA PHONE 820

NEED A PROBLEM-SOLVING PUMP?



Engineers, maintenance supervisors and plant superintendents with pumping problems swear by SK Rotary Gear Pumps. In case-after-case SK Pumps, used as original equipment or as replacements, have solved "in-service" difficulties and have given years of maintenance-free service. What these pumps have done for others, they can also do for you.

New Bulletin G-1 gives full details on standard SK Gear Pumps. Write for your copy.

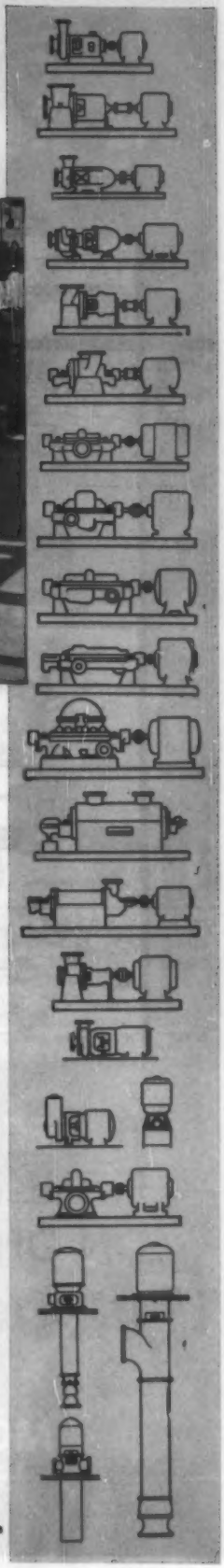
Schutte and Koerting COMPANY

2257 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Phone: MErcury 9-0900

JET APPARATUS • ROTAMETERS • GEAR PUMPS • VALVES • HEAT EXCHANGERS

HOW TO PICK A WINNER IN THE "OCTANE RACE"



Selecting the **RIGHT PUMP**

can increase the dependability and economy

of your new **DOWNSTREAM PROCESSING UNIT**

WHATEVER process you pick for upgrading motor fuel octane, its performance depends on PUMPS!

Here are some facts to help you choose wisely

● **STANDARD PUMPS** save on initial investment and should be used where they can meet the exact requirements. Ingersoll-Rand makes the *most complete* line of centrifugal pumps available from any one source, and can supply standard units for practically any job—including many that would be "special" for other manufacturers.

● **SPECIAL PUMPS** and materials may be required for some downstream applications. If the right pump isn't to be found in the standard line, I-R can build it, with maximum utilization of standard parts and designs.

● **OPERATING COSTS** depend not only on published performance curves, but on *sustained* high efficiency. And I-R pumps have built their reputation on long-term efficiency, with running clearances that can be maintained for years without frequent replacement of parts.

● **INTERCHANGEABILITY** of parts between similar pump designs can materially reduce your spare parts inventory. The degree to which this has been achieved in each class of I-R pumps can be demonstrated with available interchangeability charts.

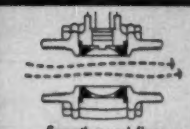
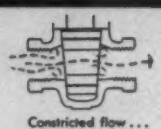
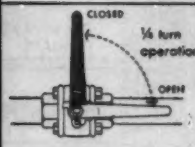
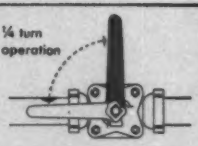
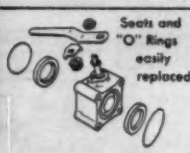
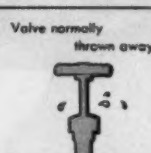
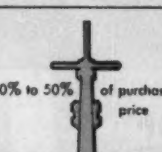
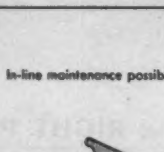
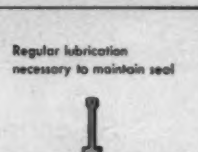
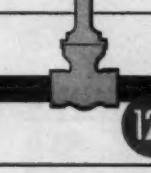
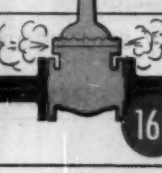
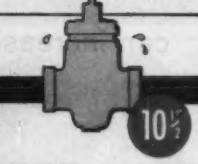
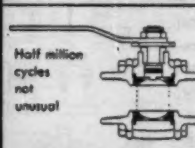
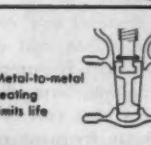
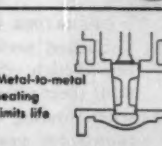
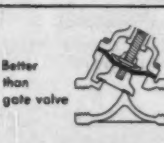
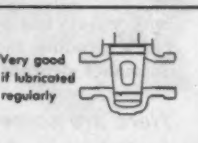
● **ENGINEERING SERVICE** by I-R pump specialists can help you every step of the way—from initial selection to installation and operation. There's no substitute for experience in engineered products, and when it comes to centrifugal pumps, Ingersoll-Rand's experience is second to none.

Ingersoll-Rand

10-914 11 Broadway, New York 4, N.Y.

Compressors • Gas & Diesel Engines • Pumps • Air & Electric Tools • Condensers • Vacuum Equipment • Rock Drills

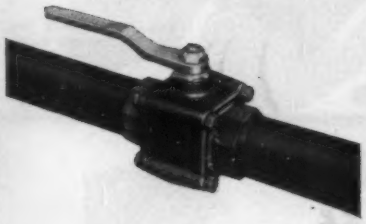
COMPARE . . .

	ECON-O-MISER	GATE VALVE	FLANGED GATE VALVE	DIAPHRAGM VALVE	LUBRICATED PLUG VALVE
FLOW CHARACTERISTICS	 Smooth round flow	Turbulence results in excessive pressure drop	Turbulence results in excessive pressure drop	Turbulence results in unusually high pressure drop	 Constricted flow . . . pressure drop
NUMBER OF TURNS		2½ to 3½ turns of hand wheel	2½ to 7 turns of hand wheel	2½ to 3½ turns of hand wheel	 ¼ turn operation
MAINTENANCE CHARACTERISTICS	 Seats and "O" Rings easily replaced	 Valve normally thrown away	 30% to 50% of purchase price	 In-line maintenance possible	 Regular lubrication necessary to maintain seal
FACE TO FACE		 12⅔	 16½	7¼	 10½
LIFE EXPECTANCY	 Half million cycles not unusual	 Metal-to-metal seating limits life	 Metal-to-metal seating limits life	 Better than gate valve	 Very good if lubricated regularly

THE ECON-O-MISER BALL VALVE IS THE IDEAL REPLACEMENT FOR MOST ON-OFF VALVES NOW IN USE IN THE PROCESS INDUSTRIES!

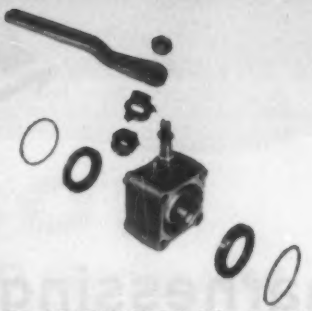
MORE EFFICIENT . . . LESS COSTLY

THE ECON-O-MISER BALL VALVE



Compact, efficient ECON-O-MISER Ball Valves are today's smoothest operating on-off valves. A quarter turn of the handle allows full operation and you can tell at a glance whether the valve is open or closed. More . . . ECON-O-MISER Ball Valves act as both valve and union . . . eliminate costly inventory and labor. Minimum turbulence and greater economy make this valve ideal for hundreds of applications.

Remove four nuts . . . four bolts . . . and the entire center section lifts out for servicing. Quick, convenient maintenance saves money and this unique design means pipe ends never have to be removed from the line. Seating surfaces and O-Rings are easily replaced . . . whole valve back in operation in minutes. Reduces inventory expenses and frees maintenance personnel from time consuming repairs.



The ECON-O-MISER Ball Valve is available in many combinations of seats, O-Rings and body materials. Almost any media can be handled by the ECON-O-MISER and sizes range from ¼" through 6". Made of bronze, aluminum, carbon steel, stainless steel or aluminum bronze. We'll be happy to furnish information or application data.

THE ONLY VALVE IN INDUSTRY THAT SERVES AS BOTH VALVE AND UNION!

Complete, technical information in new "Comparison" bulletin.

Request EB 101 on your letterhead or fill in coupon.

NAME _____ TITLE _____

COMPANY _____

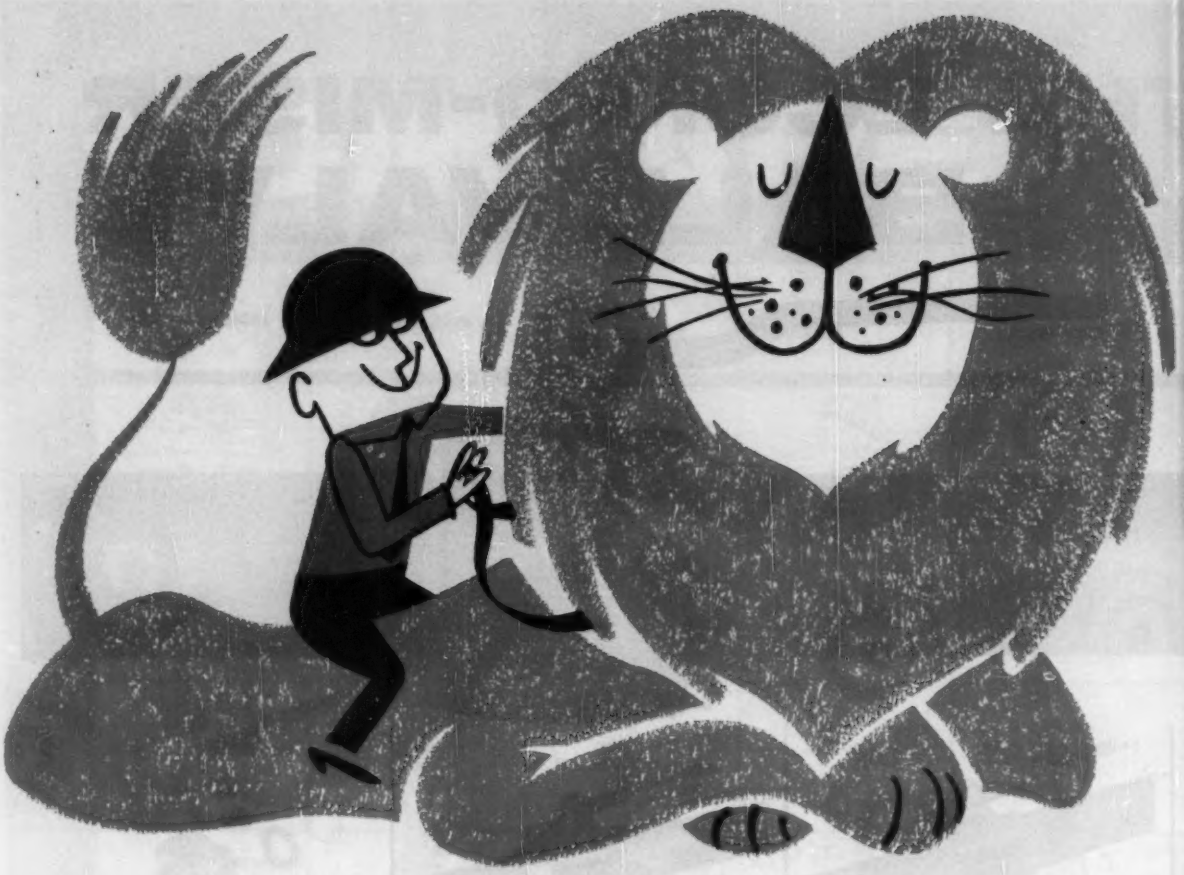
ADDRESS _____

CITY _____ STATE _____

☐ Please forward bulletin EB 101. ☐ Please ask sales engineer to call for appointment. ☐ Send information on ECON-O-MISER FLANGE BALL VALVE.

WORCESTER VALVE CO., INC.

DEPT. B • 16 PARKER STREET • WORCESTER, MASS.



harnessing HF pays off

... Pennsalt experience helps you do it

Hydrofluoric acid alkylation gives you lower catalyst cost per barrel of alkylate . . . shortens reaction time and catalyst settling time . . . reduces cooling equipment expense . . . eliminates spent acid problems and large acid inventories. You can cash in on these economies because . . .

HF can be handled safely . . . as safely as many other active chemicals you're already using.

Expert technical aid from Pennsalt shows you how to handle and store HF . . . advises you on piping, valves and other equipment and materials . . . helps you with employee training programs. We offer you this service because . . .

Pennsalt specializes in HF. We've pioneered in developing ways to make, ship and store it better, safer and more economically. Pennsalt® HF meets or surpasses alkylation process purity requirements. Ample supplies available, in cylinders and tank cars of convenient sizes. Call or write for more information or ordering.

See our catalog in CMC

INDUSTRIAL CHEMICALS DIVISION

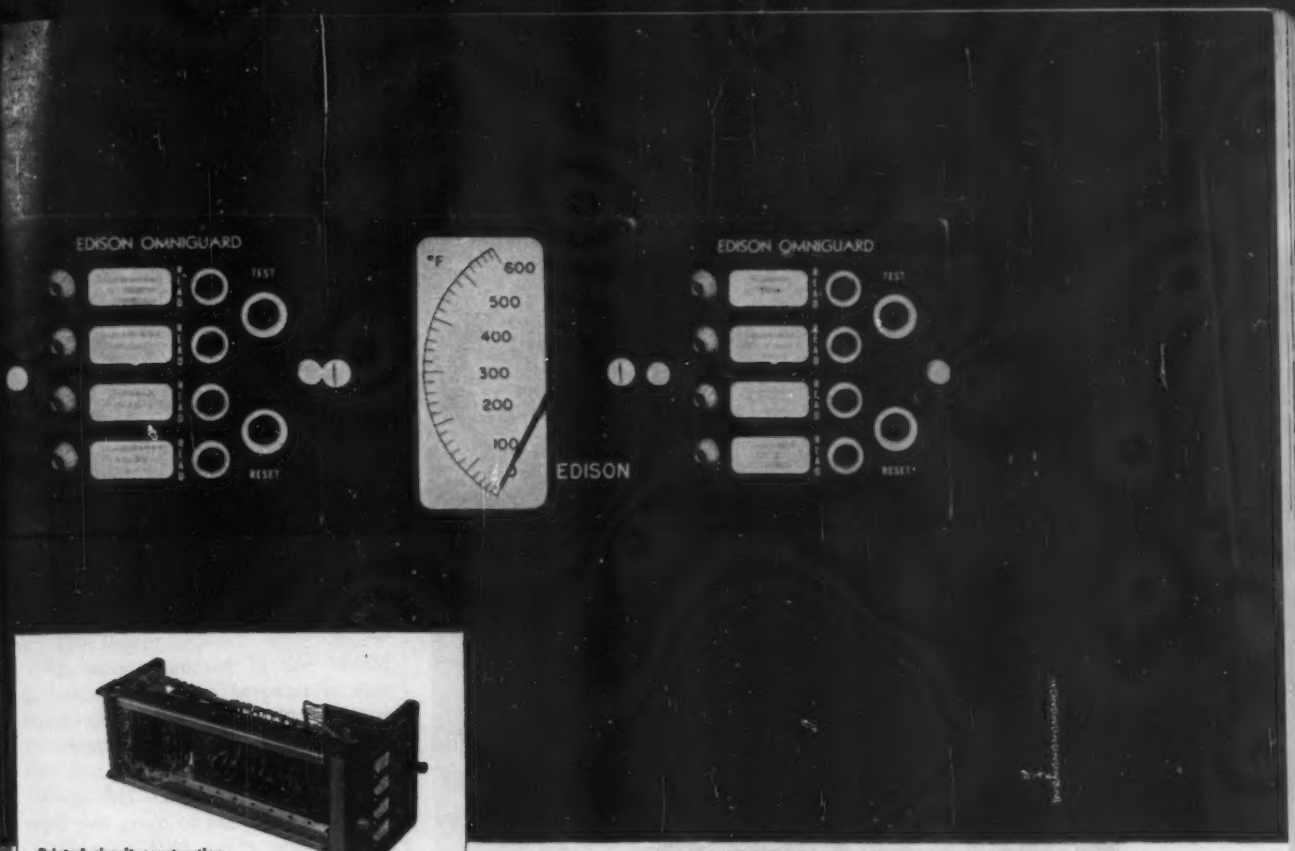
PENNSALT CHEMICALS CORPORATION

3 Penn Center, Philadelphia 2, Pa.

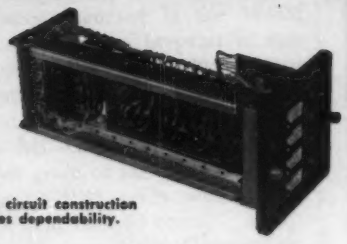
Chicago • Detroit • New York • Philadelphia • Pittsburgh • St. Louis • Appleton • Atlanta
Airco Company International, New York • Pennsalt Chemicals of Canada Ltd., Oakville, Ontario

Pennsalt Chemicals
ESTABLISHED 1850

In the West, Pennsalt inorganic chemicals are available through Pennsalt of Washington Division, with plants at Tacoma, Washington and Portland, Oregon.

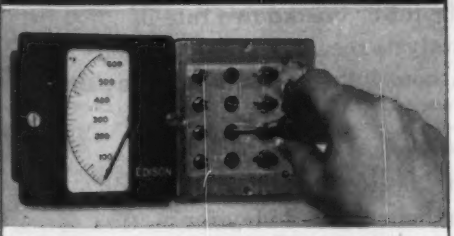


Model 310 Edison Omniguard with Model 311 Indicator — a single indicator can read any number of temperature points.



Printed circuit construction increases dependability.

Highest quality components, with no moving parts, assure maintenance-free operation.



Easy access to all components permits quick temperature settings and monitoring system changes – at any time.

THOMAS A.

EDISON

new model 310 omniguard temperature monitor... unmatched for versatility

The new Model 310 Edison Omniguard provides the simplest, most dependable temperature detection system yet devised... for both small and large installations.

The Omniguard system is reliable... flexible... economical. You order only the plug-in units needed, add new units as your monitoring needs expand.

Check these features of the new Edison Omniguard:

1. VERSATILE: One instrument can be used for both normally open and normally closed annunciator... for alarm or for shutdown of equipment.

2. FLEXIBLE: Quick, inexpensive system changes and additions . . . easy tie-in with any type annunciators or cut-off switches.

3. DEPENDABLE: Rugged design with highest quality components, no fragile moving parts.

4. SIMPLE: Single indicator reads any number of temperatures, needs no periodic adjustment. With a minute's briefing, *anyone* can operate the simple Omniguard monitoring system.

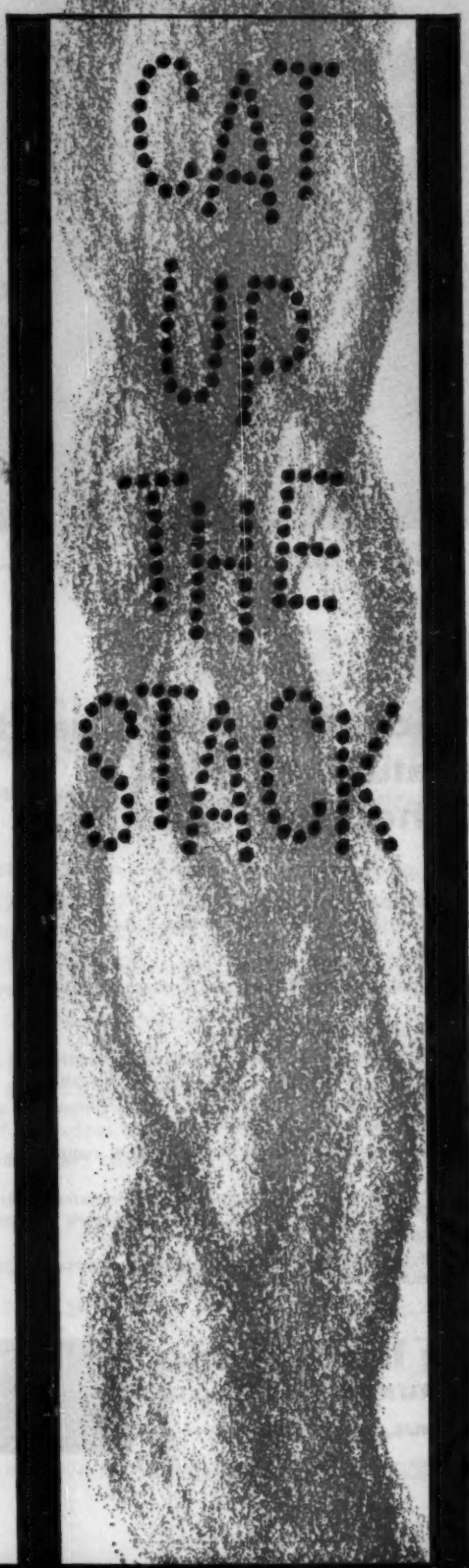
5. LOW COST: Plug-in units can be custom-tailored to your exact requirements . . . order additional units only when needed.

Thomas A. Edison Industries

INSTRUMENT DIVISION

96 LAKESIDE AVENUE, WEST ORANGE, N. J.

EDISON ENGINEERING OFFICES ARE LOCATED IN: WASHINGTON—BALTIMORE; CHICAGO; DALLAS; DAYTON; LOS ANGELES



with Davison Catalysts

Your stack carries away regeneration gases —not catalyst—when you put Davison in your unit. Here's why:

With Davison Catalysts you get the lowest amount of unretainable fines.

With Davison Catalysts you get lower attrition. The lower breakdown rate of Davison Catalysts means you get the fines you need without light particles escaping up the stack.

The reason: *balanced density*. There's a Davison Catalyst to suit your application. Write Department 391P today for Product Service Bulletin No. 59-101.

W.R. GRACE & CO.
DAVISON CHEMICAL DIVISION
BALTIMORE 3, MARYLAND

The Mail Box . . .

Put to Use

To The Editor:

I am interested in a young man who has his bachelor's degree in electrical engineering and is presently in a graduate school studying business administration. I believe your article "What Price Professionalism?" in the February 1959 PETROLEUM REFINER (Page 193) would be of as much interest and value to him as it was to me. So I am arranging to send him a copy which I am sure will be put to good use.

H. T. Ferree

Wynnewood, Pa.

Preprint Mistakes

To The Editor,

An error occurred in the World Petroleum Congress preprint of material which was used in PETROLEUM REFINER (June 1959, Page 197). In the first paragraph of the section "What MD-CMT Will Cost," the price per gram of manganese content is given at 9.85 cents whereas the figure should be 0.85 cents.

T. W. Warren, Ethyl Corporation, Detroit, Mich.

To The Editor,

I wish to call to your attention an error in Table 1 on page 170 (June issue, Mekler and Brooks, **"When Is Delayed Coking Worthwhile"**), which existed in the orignal API preprint. The numbers applying to "Ratio of combined feed to fresh feed" should really apply to "Ratio of combined feed to equivalent fresh feed," and the numbers for the "Ratio of combined feed to equivalent fresh feed" should refer to "Ratio of combined feed to fresh feed."

Also, the paper was not presented by Mr. Mekler but by the writer.

M. E. Brooks

New York City

Errata

An error was made in the biographical sketches of Dr. F. Kurata and W. E. Clark, authors of "Freezing CO_2 from Natural Gas," June issue, Page 251. The information under each author's name was inadvertently transposed, so that what appears to be Dr. Kurata's background is actually Mr. Clark's, and vice versa. Also, Mr. Clark is working on one but has not completed all requirements for his doctorate.

600-foot length of Thermoid-Quaker hose, self-propelled both off and on the reel, floated on inflatable rubber "sausages."

Quaker Thermoid floating ship-to-shore rig helps speed oil storage for new arctic air base

Increased air traffic over the polar route has called for an immense new airfield and oil-piping system at Frobisher Bay, Baffin Island, just completed by Foundation Company of Canada Limited.

Tankers pump petroleum products through a 600-foot Thermoid-Quaker Floater Hose assembly to a 15,000-foot pipeline feeding the huge tank farm at Frobisher. An 8" Thermoid-Quaker discharge hose is floated on special inflatable Thermoid-Quaker pontoons and reeled on a power winch. This three-part rig makes up the complete Thermoid-Quaker assembly.

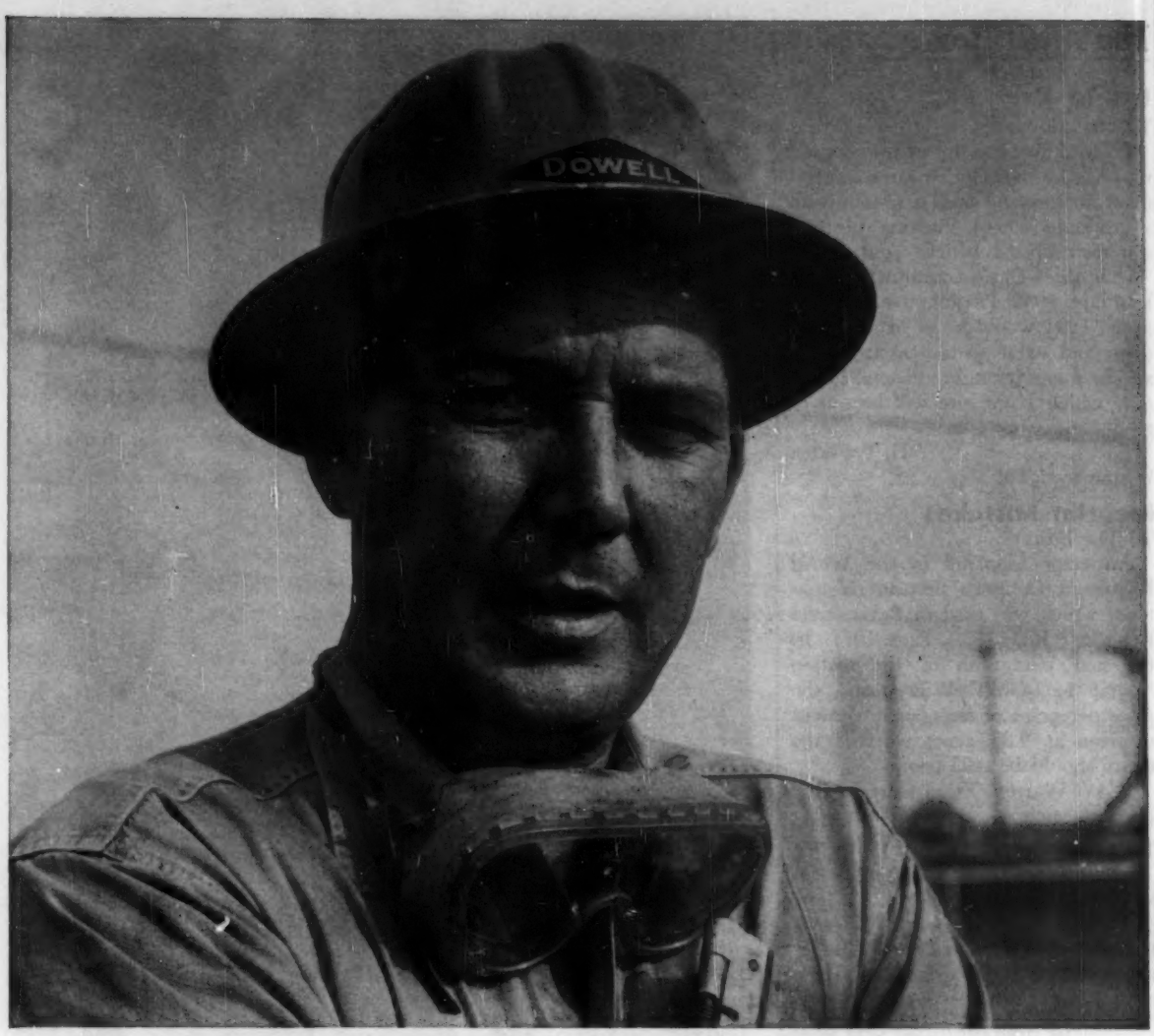
You do away with bulky metal drums for floating hose when you use this new Thermoid-Quaker rig. Inflatable floats take up less than a quarter of the space formerly required by floating drums. And the hose comes in such long sections that couplings are reduced by as much as 90%.

If you load or unload tankers off-shore, investigate the Thermoid-Quaker Floater Hose combinati n. Ask the Thermoid distributor, or write *Thermoid Division, H. K. Porter Company, Inc., Tacony & Comly Sts., Philadelphia 24, Pa.*

THERMOID PORTER DIVISION

H.K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Copper and Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION, H. K. PORTER COMPANY DE MEXICO, S. A.; and in Canada, Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.



This Man Can Help You Get More Efficiency From Plant Equipment

Efficiency is what you want from your plant equipment, and the Dowell engineer can help you get it. Plants in every major industry—for example, oil refining, chemical, public utility, steel and paper—are getting productive results from *economical* chemical cleaning by Dowell.

To remove scale and sludge from your process equipment, boilers, tanks and piping, Dowell engineers provide knowledge and tools you can get from no other chemical cleaning service. You get cleaning knowledge gained from developing and working with the rigorous cleaning standards of the missile program at Cape Canaveral. You get new tools and chemicals from a continuous research program. For example, Dowell recently introduced a new high-velocity jetting device for cleaning tube bundles.

And you get 20 years' worth of experience in all types of industry from Maine to California. Plant operators find it pays to call Dowell on even the smallest job. But they also know that Dowell has the manpower and equipment to clean the largest and most complex systems.

The Dowell engineer takes pride in doing your job so well that you will continue to call him for your cleaning work. This desire to do your job well covers every facet of service—from seeing that you get solvents exactly as specified, to supervising Dowell's full-time safety program. Every precaution is used to protect your personnel and equipment.

Prompt service and detailed information is yours from any of the 165 Dowell stations and offices. Get more efficiency—economically—with the help of the largest, the oldest, the most experienced chemical cleaning service—Dowell, Tulsa 1, Oklahoma.

Chemical cleaning service for all industry

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

COSTS!

Sharp economics, most of us agree, are essential under today's business conditions. Proposed capital expenditures cannot be checked too carefully and over-all plant economy calls for constant review. So, the Special Report on Costs and Economics which follows will help you meet today's economic demands.

When adding new processing facilities, often the utilities and auxiliary services for the entire plant must be increased. How many times has the new steam plant or cooling tower actually sunk a new project. "How to Distribute Auxiliary Costs," Page 110, gives a method for allocating these costs which is based on the percent of the total utility required by each process unit operating at rated capacity.

Inflation is the greatest threat on today's economy. It must be countered on all fronts, in industry and elsewhere. "Include Inflation in Cost Accounting," Page 113, explains this hidden expense and shows ways for including it in depreciation accounting. Setting aside dollars for replacing worn out equipment is not enough, provision must be made to purchase replacement equipment at its then prevailing price.

Deciding which of several proposed projects will get the investment money is a difficult and often thankless task. The most useful tool for making this evaluation is the interest rate of return. However, even this method has its limitations. On Page 117 you'll find a guide to using this evaluation procedure as well as tips on its shortcomings.

Models can be useful for many things other than construction and design. An interesting use for models by Du Pont starts on Page 121. This method relies heavily on manufacturers' equipment drawings and less detail in the model. It has been so successful that Du Pont has obtained better arranged and more economical plant design in less time and with lower engineering costs.

Air conditioning could probably be justified if you could find the approximate cost quickly and easily. There's a solution to this problem of estimating industrial air conditioning on Page 123. The charts and design data will permit rapid estimation with high accuracy.

An exchanger which costs less and operates better can result from a careful study of pressure drop versus pumping costs. Keeping pressure drop to a minimum results in two things—high initial costs and trouble with fouled exchangers when operating at part capacity or in cold weather. Turn to Page 129 for some quick comparisons as to what can be accomplished with optimum pressure drop.

Thomas C. Ponder
PETROCHEMICALS EDITOR

How to Distribute Auxiliary Costs

Here is a method for allocating auxiliary capital and costs for process plants which is based on the percent of the total utility required by the product plant operating at rated capacity

W. H. Stanton
Monsanto Chemical Company, Texas City, Texas

THE IMPORTANT factor in judging the worth of a product to a company is the return realized on the capital invested in that product. The capital required and the costs associated with the direct production of a product are readily collected.

However, there are many other auxiliary charges which are only indirectly associated with the manufacture of the product. These would include the capital and cost associated with the production of steam, electricity, cooling water and other utilities, plus the capital in roads, lands, shops and other service facilities. This article deals with assignment of these auxiliary capital and costs to the products.

The normal system of allocation is to assign to each product its fair share of each operation it depends upon. This is done by estimating the product's percentage use of each auxiliary facility. Simplifying assumptions are made to reduce the detailed work required.

To illustrate the allocation of capital and costs, data on an imaginary operation are presented. Then the suggested method of allocation is shown by completing the calculations of total capital and costs to each product.

Capital and costs to be allocated are tabulated. Table 1 summarizes data on capital investment. Table 2 summarizes data on utility and service costs.

TABLE 1—Capital Summary
(Figures in Millions of Dollars)

Manufacturing Capital	
Product No. 1	5.0
2	3.0
3	1.0
4	5.0
5	11.0
6	1.0
7	3.0
8	5.0
9	10.0
10	6.0
Total Manufacturing Capital	50.0
Utility Capital	
Stream	5.0
Electricity	1.0
Cooling Tower Water	2.0
Total Utility Capital	8.0
Service Capital	
Barge Docks	0.5
Control Laboratory	0.2
Dispensary	0.1
Employe Service Facilities	0.2
Fire Protection	0.3
Land	1.0
Office	0.5
Plant Trucks	0.2
Research Laboratory	1.0
Roads & Walkways	1.0
Sewers	0.3
Shops	1.0
Stores	0.2
Miscellaneous	1.5
Total Service Capital	8.0
Total Capital	66.0

The utility use by each product plant operating at its rated capacity and for the current month is tabulated. Percent of total utility demand figures by each of the products is calculated (See Tables 3 and 4)

Capital Allocation. Capital is allocated to the products as follows:

1. Manufacturing capital are those assets within the confines of the site where the product is made. One-hundred percent of this capital is carried by the product.

2. Utility capital is allocated to the products based on percent of the total utility required by the product plant operating at rated capacity. Table 3 lists present use figures. Table 5 summarizes utility capital allocation.

TABLE 2—Utility and Service Costs

	Unit Raw Mat'l. Costs	Fixed Operating Costs $/mo.
Utilities		
Steam	$0.25 M Btu	$125,000
Electricity (Purchased)	0.01/Kwh	10,000
Cooling Tower Water	0.001/M gal	35,000
		$170,000
Services		
Barge Docks		$ 1,000
Control Laboratory		20,000
Dispensary		2,000
Employee Service Facilities		2,000
Etc.		75,000
Total Services		$100,000

TABLE 3—Utility Use by Product Plants

Operating at Rated Capacity

Product Plant No.	M Btu/mo Steam	KWH/mo Electricity	M gal/mo Cooling Tower Water
1	10,000	200,000	200,000
2	60,000	25,000	300,000
3	10,000	75,000	200,000
4	200,000	300,000	800,000
5	100,000	300,000	500,000
6	.....	100,000	10,000
7	20,000	200,000	100,000
8	10,000	30,000	10,000
9	40,000	3,000,000	80,000
10	50,000	400,000	300,000
Total	500,000	4,630,000	2,500,000

Actual Use for Current Month

Product Plant No.	M Btu Steam	KWH Electricity	M gal Cooling Tower Water
1	8,000	160,000	160,000
2	65,000	27,000	320,000
3	7,000	65,000	140,000
4	150,000	200,000	500,000
5	50,000	150,000	250,000
6	.....	100,000	10,000
7	25,000	250,000	125,000
8	7,000	20,000	7,000
9	30,000	2,000,000	60,000
10	47,000	400,000	270,000
Total	389,000	3,372,000	1,842,000

3. Service capital is allocated to the products by proportioning as follows:

$$\frac{\text{Manufacturing Capital Plant 1}}{\text{Total Manufacturing Capital}} = \frac{\text{Service Capital Allocated to Plant 1}}{\text{Total Service Capital}}$$

Service capital allocations are summarized in Table 6 as is total capital allocated to each product.

Such a system of capital allocation can be done by clerical help with little training. It is not a big job to allocate capital and can be kept current by being done each quarter or even each month.

Inaccuracies. Often simplified systems that are quick are also inaccurate. Is this true here? Somewhat.

TABLE 4—Percent of Total Utility Demand by Each Product Plant

Operating at Rated Capacity

Product Plant No.	PERCENT OF TOTAL UTILITY USED BY PRODUCT PLANTS: Steam Percent	Electricity Percent	Cooling Water Percent
1	2	4.0	8
2	12	.5	12
3	2	1.5	8
4	40	6.0	32
5	20	6.0	20
6	...	2.0	0.5
7	4	4.0	4
8	2	1.0	0.5
9	8	66.0	3
10	10	9.0	12
Total	100	100	100

Operations for Current Month

Product Plant No.	PERCENT OF TOTAL UTILITY USED BY PRODUCT PLANT: Steam Percent	Electricity Percent	Cooling Water Percent
1	2	5	9
2	17	1	17
3	2	2	8
4	39	6	27
5	13	4.5	13
6	...	3	0.5
7	6	7	7
8	2	0.5	0.5
9	7	59	3
10	12	12	15
Total	100	100	100

TABLE 5—Distribution of Utility Capital[1]

Product Plant No.	UTILITY: Steam	Electricity	Cooling Water
1	100,000	40,000	160,000
2	600,000	5,000	240,000
3	100,000	15,000	160,000
4	2,000,000	60,000	640,000
5	1,000,000	60,000	400,000
6	.....	20,000	10,000
7	200,000	40,000	80,000
8	100,000	10,000	10,000
9	400,000	660,000	60,000
10	500,000	90,000	240,000
Total	5,000,000	1,000,000	2,000,000

[1] Based on use of utility by the product plants when operating at rated capacity.

About the Author

W. H. Stanton is manager of engineering planning for Monsanto Chemical Co., Texas City. He received a B.S. degree in chemical engineering from Purdue University in 1942 and joined Monsanto the same year. He has worked primarily as a process engineer in plant design at St. Louis, Springfield, Mass.; Columbia, Tenn.; Marshall, Texas; and Texas City, where he has been since 1951. Stanton has worked in many of Monsanto's larger petrochemical plants and is presently in project evaluation and facilities planning.

For instance, the steam plant probably generates much more steam than the manufacturing plants consume even when they are operating at their full capacity. The extra steam is used internally within the steam plant or perhaps in generating electricity. If the steam is used internally, the system described is still allright; but, if much of the steam is used to generate electricity, then there is a misallocation. If steam is used to generate electricity in your plant, then take it into account; revise the suggested system so the electrical facilities carry their fair share of the steam plant; and finally proportion the increased capital in the electrical plant to the consuming process units. Judgment must be applied in setting the detail required in allocating capital within a specific plant.

The calculated total fixed capital in each product is used principally to evaluate the investment that a company has in that single product. A common method of investment analysis is "percent return on investment." This is the ratio of annual earnings multiplied by 100 to total capital. A variation of 10 percent in total capital, on an average, might vary rate of return by 1 percent. This degree of error

would be allowable in judging most investments; thus, auxiliary capital allocated by the method described is normally accurate enough to satisfy the end use to which total capital is placed.

Cost Allocation. A detailed discussion of cost allocation is not attempted in this article. In principle, costs are allocated to the products as follows:

1. One-hundred percent of the manufacturing cost of producing a product for the current month is allocated to the product.

2. Utility costs are divided into variable and fixed costs.

Raw materials for the utilities are considered a variable cost and are charged as a direct function of their use in producing the product. See Table 4 for the calculated percent use by each product of each utility for the current month.

Fixed utility costs are allocated in a manner similar to utility capital allocation. Each manufacturing unit, regardless of the rate at which it operates, is charged each month with a portion of the fixed costs. See Table 3 for the calculated percent use by each product running at rated capacity.

3. Service costs are carried by the products in a manner similar to service capital allocation. Thus Plant 1 has 10 percent of the total manufacturing capital and therefore carries 10 percent of the service capital and service costs.

Such a system of cost allocation has the advantages of avoiding widely varying utility costs as production rates fluctuate in product plants. If one of the product plants runs at 50 percent of its rated capacity, it still carries a set portion of utility costs. These costs are not pushed off on a product that manages to run at capacity. This would happen if utilities were charged at their actual cost on the basis of use alone.

To complete the illustration, Table 6 summarizes utility and service costs associated with the production of each product. These would be added to the manufacturing cost sheet for each product in computing its cost of production.

Plants Under Construction. Most companies have new plants under construction. This capital should be carried as a separate entry on the company profit and loss sheet, until the job is complete and the plant capable of production. At this time the new plant would be added to the list of producing plants and it would carry its manufacturing capital plus an allocation of utility and service capital. Start-up charges on the new plant would also be carried as a separate entry on the company profit and loss sheet.

Research, Engineering, Sales and Administrative Expenses. The continuing costs of research, engineering, sales and administration are charged, as they apply, against the products directly benefiting from such costs. Of course much of the research, engineering, sales and administration efforts is directly toward the future and existing plants do not receive the direct benefits of this effort. Nevertheless, they must carry these costs. Here the costs should be proportioned to existing plants just as service department costs are carried. ##

TABLE 6—Capital Allocation Summary

Product No.	Mfg. $\overline{\$M}$	Percent of Total Mfg. Capital	ALLOCATED PORTION OF TOTAL		Total Assigned
			Utility $\overline{\$M}$	Service $\overline{\$M}$	Capital $\overline{\$M}$
1	5.0	10 Percent	.30	0.80	6.10
2	3.0	6	.85	0.48	4.33
3	1.0	2	.28	0.16	1.44
4	5.0	10	2.70	0.80	8.50
5	11.0	22	1.46	1.76	14.22
6	1.0	2	.03	0.16	1.19
7	3.0	6	.32	0.48	3.80
8	5.0	10	.12	0.80	5.92
9	10.0	20	1.12	1.60	12.72
10	6.0	12	.82	0.96	7.78
Total	50.0	100 Percent	8.00	8.00	66.00

TABLE 7—Distribution of Utility and Service Costs

Distribution of Utility Costs

Product No.	RAW MATERIAL COSTS[1]			FIXED COSTS[2]			Total
	Steam	Elec.	Ct. Water	Steam	Elec.	Ct. Water	
1	2,000	1,600	160	2,500	400	2,800	9,460
2	16,000	200	320	15,000	50	4,200	35,770
3	2,000	700	140	2,500	150	2,800	8,290
4	37,000	2,000	500	50,000	600	11,200	101,300
5	13,000	1,500	250	25,000	600	7,000	47,350
6	.....	1,000	10	.....	200	175	1,385
7	6,000	2,500	125	5,000	400	1,400	15,425
8	2,000	200	7	2,500	100	175	4,982
9	8,000	20,000	60	10,000	6,600	1,050	45,710
10	12,000	4,000	270	12,500	900	4,200	33,870
Total	98,000	33,700	1,842	125,000	10,000	35,000	303,542

Distribution of Service Costs

Product Plant No.	Service Costs
1	10,000
2	6,000
3	2,000
4	10,000
5	22,000
6	2,000
7	6,000
8	10,000
9	20,000
10	12,000
Total	$100,000

[1] Based on current monthly use of utilities by the product plants.
[2] Based on monthly use of utilities by the product plants when operating at rated capacity.

Include Inflation in Cost Accounting

The allowance for inflation concept offers a simple but exact means for calculating true cost of keeping up with inflation

F. C. Jelen, Syracuse, N. Y.

INFLATION DIRECTLY INCREASES COSTS. The direct consequences, such as increased wages and the cost of goods and services purchased from others, are readily recognized.

Inflation also creates *hidden* expenses. The complete extent of these hidden expenses has been overlooked. Purpose of this article is to demonstrate how they can be computed in full. Indeed, the allowance for inflation can be defined as the total hidden expense arising from inflation on an *after* tax basis.

The oil and associated industries have a high capitalization and many of the assets are long lasting. Consequently these industries are particularly vulnerable to the hidden expenses of inflation.

The allowance for inflation concept offers a simple but exact means for calculating the true cost of keeping up with inflation. The calculation is made on a year to year basis and is always up to date.

If no allowance for inflation is made "profits" and "rate of return on investment" are overestimated in an inflationary period. A company might even be shrinking despite the appearance of operating in the black.

The Variable Dollar. The concept of an allowance for inflation is merely an engineering approach to the problem of a varying unit, the dollar. Engineers handle variables every day without confusion.

The tools of management, such as the income statement and the balance sheet, use the current dollar as an expression of value. However, such forms, directly and indirectly, contain dollars of other years and other values. It is not practical to use a fixed dollar as a fixed base since it is only the current dollar which has current meaning. The current dollar is a moving base and can be used as a fixed base only momentarily.

Obviously, corrections must be made to keep up with the changing base, the depreciating dollar. The corrections are true expenses—the hidden expenses arising from inflation.

Allowance for Inflation. Denote the allowance for inflation for the x-th year, and taken at the end of the x-th year, as $(ai)_x$. Then:

$$(ai)_x = A_{(x-1)}\, N_x \qquad (1)$$

$$\text{where } N_x = \frac{I_x - I_{(x-1)}}{I_{(x-1)}}$$

In Equation (1) $A_{(x-1)}$ is the asset value at the beginning of the x-th year. The symbol I designates the numerical value of a suitable cost index. Specifically, I_x is the value of the index at the end of the x-th year and $I_{(x-1)}$ the value at the beginning of the x-th year. The factor N_x is the *decimal* allowance for inflation for the x-th year. It depends only on the course of inflation during the year.

The significance of Equation (1) will be evident from an example which follows. The equation embraces several considerations which should be noted.

The calculation is made on a year to year basis. The allowance for inflation is always up to date.

All the hidden costs of inflation can be included since all the assets can be considered.

The allowance for inflation is independent of the manner in which depreciation is taken since the depreciation for the year does not enter the computation. The allowance for inflation is determined entirely by the course of inflation.

The equation uses a moving base for the asset value, that is the asset value changes from year to year and keeps in step with inflation. The artificiality of using any fixed year as an arbitrary base has been eliminated.

A Simple Numerical Example. An example will illustrate the use of Equation (1) and the calculation of the allowance for inflation.

Suppose an asset is bought for $1 million and is depreciated over a two year life using straight line depreciation. Depreciation will be $500,000 per year, but actually the allowance for inflation will not depend upon how depreciation is taken.

For simplicity assume the allowance for depreciation is deposited as cash and that no "real" retained profits are accumulated. The cost index for the asset is given in Table 1. The index is not known in advance but develops with time. The asset is purchased at zero time when the index is 188.

Table 1—A Hypothetical Cost Index

End of Year	Cost Index
0	188
1	192
2	197

The balance sheet at the time the asset is purchased is given in Table 2.

Table 2—Beginning of 1st Year

Fixed assets at cost	$1,000,000	Capital Stock	$1,000,000
Less depreciation	000,000		
	$1,000,000		

At the end of the first year there is $500,000 depreciation. The allowance for inflation from Equation (1) and Table 1 is:

$$(ai)_1 = A_0\,(I_1 - I_0)\,/I_0$$
$$= (1{,}000{,}000)\;(192 - 188)\;/188 = \$21{,}276.$$

The balance sheet at the end of the first year is given in Table 3.

Table 3—End of 1st Year

Fixed assets at cost	$1,000,000	Capital stock	$1,000,000
Less depreciation	500,000	Allowance for	
	$ 500,000	inflation	21,276
Cash	521,276		$1,021,276
	$1,021,276		

For the second year the depreciation is again $500,000. The allowance for inflation from Equation (1) and Table 1 is:

$$(ai)_2 = (A_1)\ (I_2 - I_1)\ /I_1$$
$$= (1{,}021{,}276)\ (197 - 192)\ /192 = \$26{,}596.$$

Note that the asset value is A_1 which is $1,021,276 It would be incorrect to use $1,000,000 which is the original cost and only A_0.

The balance sheet at the end of the second year is given in Table 4.

Table 4—End of 2nd Year

Fixed assets at cost	$1,000,000	Capital stock	$1,000,000
Less depreciation	1,000,000		
	$0,000,000	Allowance for	
Cash	1,047,872	inflation	47,872
	$1,047,872		$1,047,872

The cost of a replacement at the end of the second year is:

$$A_2 = (A_0)\ (I_2)\ /I_0$$
$$= (1{,}000{,}000)\ (197)\ /188 = \$1{,}047{,}872.$$

This is precisely the cash on hand for a replacement if replacement is to be made at that time.

At zero time the company had $1 million which was exactly sufficient in dollars at that time to purchase the asset. At the end of two years the company has $1,047,872 in depreciated dollars which are sufficient only to replace the asset at that time. The company is exactly the same company that it was.

The allowance for inflation amounting to $47,872 for the two years has merely permitted the company to stay even with inflation.

In a large company assets are replaced on a continuous basis and many not in kind. Cash balances for depreciation are not accumulated as such. Depreciation is treated as an expense representing the original cost spread over the years of use. The example was simplified for the convenience of presentation. Nevertheless the principle is true regardless of how the depreciation is transferred to other assets. The allowance for inflation is computed from the asset value, after allowing for depreciation, and generally even such items as cash should be included.

Assets. The allowance for inflation for each year is calculated from the asset value, hence it is necessary to analyze the assets to determine exactly how they are to be considered in the calculation. Generally speaking, most assets enter the calculation.

The status of an asset can be determined by a simple criterion. If the asset is such that the progress of inflation will of itself require the accumulation of extra dollars to keep the asset in step with inflation, then the asset should be included in the calculation for the allowance for inflation.

In a manufacturing company the principal assets which are *not* included are land and permanent improvements thereon, capital stock of other companies, and franchises if perpetual. All these assets will increase in value along with inflation and will hold their own without the addition of extra dollars even though they are held at cost.

All other assets of a manufacturing company should be included in the calculation in general. This applies to cash which definitely suffers from the course of inflation. More and more cash will be required just to stay even with inflation, and the extra cash will have to come from the allowance for inflation.

Whatever the asset, the allowance for inflation should always be made after deductions for depreciation, amortization, depletion and similar charges. Such deductions will appear as other assets.

One consideration should be clarified. In a manufacturing company the allowance for inflation should be made from a consideration of the assets without regard to how the money was raised to create the assets. Once money is raised, even if by a bond issue which is payable on a dollar for dollar basis, the assets which are created must be protected against the course of inflation.

The Cost Index. It is not the intention here to enumerate or evaluate various cost indexes but only to show how an index is used in the calculation for allowance for inflation. Several cost indexes have been discussed elsewhere.[1]

The allowance for inflation is calculated on the basis of the depreciation of the dollar. The only practical way to determine this depreciation is through a cost index. Cost indexes suitable for making calculations for the allowance for inflation already exist but it seems certain that the future will bring others compiled chiefly for the purpose. In the end accountants and others may agree on the acceptance of prescribed indexes to remove the arbitrariness of a single company selecting its own indexes.

A large company may find it necessary to group the assets into a few categories and employ separate cost indexes for each group, but the use of more than a few groups is to be discouraged. For some assets, such as cash, there may be no apparent cost index, but the decision can be made from a consideration of why the asset exists. For a manufacturing company the cost index for cash could well be an equipment cost index, a construction cost index, or a combination of both.

Allowance for Inflation Is an Expense. The allowance for inflation is an expense and the expense is occurring whether it is recognized or not.

The allowance for inflation as presented here is on an after tax basis, and at the current income tax rate the expense before taxes is slightly more than double. Suppose that a company must absorb an allowance for inflation amounting to $1,000,000 for the coming year. At a 52 percent tax rate the expense before taxes is $1{,}000{,}000/(1 - 0.52)$ or $2,083.333. Thus $2,083,333 should be allocated to the various operations over the year by some accounting procedure.

At the end of the year $2,083,333 will be available as

income before taxes leaving $1 million after taxes to be retained as an allowance for inflation.

The allowance for inflation is a hidden expense, but the tax situation makes it doubly hidden.

Income Statement. Tables 3 and 4 showed in a simplified manner that the allowance for inflation will appear in the balance sheet. Likewise it will appear in the income statement.

First, however consider a hypothetical income statement in which no allowance for inflation has been made. Only the latter part of the income statement need be discussed. Table 5 gives the pertinent information.

Table 5

XYZ Corporation

Concluding lines in income statement for year ending Dec. 31, 19XX. No allowance for inflation.

Income before provision for income taxes	$40,000,000
Less income tax	19,000,000
Net income	$21,000,000
Less common stock dividends	5,000,000
Retain earnings for period	$16,000,000

Note 1.

Statement of retained earnings

Balance, beginning of period	$200,000,000
Add for period	16,000,000
Balance, end of period	$216,000,000

The report gives the impression that the corporation was successful by $21 million for the year, $5 million of which was paid out as dividends on the stock and $16 million of which was retained. It suggests, too, that the $16 million retained would be available for expansion. Moreover, with retained earnings totalling $216 million it appears that the corporation over the years has been able to reinvest considerable funds for expansion.

Now suppose that the corporation had been making an allowance for inflation over the years. The allowance for inflation for the year is $15 million calculated as follows:

Total assets, beginning of the year	$400,000,000
Less land at cost	20,000,000
Less stock in other Corp. at cost	5,000,000
Assets subject to allowance for inflation	$375,000,000

Inflation for year = 4 percent

Therefore $N_x = 0.04$

$$(ai)_x = (375{,}000{,}000)\ (0.04) = \$15{,}000{,}000$$

The concluding lines in the income statement for the year might be that of Table 6.

Table 6

XYZ Corporation

Concluding lines in income statement for year ending Dec. 31, 19XX. Allowance for inflation included.

Income before provision for income taxes and inflation	$40,000,000
Less income tax	19,000,000
Net income before allowance for inflation	$21,000,000
Less allowance for inflation	15,000,000
Net income after allowance for inflation	$ 6,000,000
Less common stock dividends	5,000,000
Retained earnings for period	$ 1,000,000

Note 1

Statement of allowance for inflation

Balance, beginning of period	$185,000,000
Add for period	15,000,000
Balance, end of period	$200,000,000

Note 2

Statement of retained earnings

Balance, beginning of period	$ 15,000,000
Add for period	1,000,000
Balance, end of period	$ 16,000,000

When the allowance for inflation has been included the interpretation is significantly different. The real earnings for the period were $6 million and after paying out $5 million in stock dividends only $1 million was retained as an amount available for expansion. Moreover, although a total of $216 million has been reinvested over the years, $200 million of this had to be reinvested as an allowance for inflation to merely allow the company to hold its own. Only $16 million has been reinvested over the years as funds available for expansion.

Profit. The word "profit" should be used with caution. Profit should definitely signify an amount that could be made available for expansion. In Table 6 the fifth line, net income after allowance for inflation, is the first line to which the word profit might be assigned. True profits exist only after taxes have been taken out and after an allowance for inflation has been made.

The income tax is supposed to be a profits tax but it is much more since the government does not recognize the allowance for inflation as deductible for tax purposes. When computing the base for income tax payment a corporation is not computing its real profits but more nearly a "base for the calculation of income tax."

It is possible for a company to be operating at a deficit after an allowance for inflation has been included but be subject to an income tax. The company is shrinking under such circumstances and the income tax payment represents essentially confiscation of the assets rather than a share of true profits.

Return on Investment. The return on investment is overstated when no allowance for inflation is made. Compare Tables 5 and 6 and use $400 million for the total investment in each case. Without an allowance for inflation the return on investment appears to be (21,000,000) (100)/400,000,000 or 5.3 percent. With an allowance for inflation the return on investment is (6,000,000) (100)/400,000,000 or 1.5 percent.

Accelerated Allowance for Depreciation. The inadequacy of the allowance for depreciation to pay for the cost of replacement has been apparent for some time and proposals have been made to permit more rapid write offs.[3] Indeed, the United States now allows a higher rate of depreciation during the early years of the life of an article than was formerly permissible. Many foreign countries are much more liberal.

This procedure does not give an extra allowance for depreciation. It is a benefit during the early years of life of an article but creates a disadvantage in the later years.

Extra Allowance for Depreciation. Some foreign countries, such as Belgium and Argentina, allow revaluation factors which have the effect of creating an extra allowance for depreciation. This is not permitted in the United States.

An extra allowance for depreciation at the time an asset is retired has been suggested by Peloubet.[2]

It is interesting to note that the government in the end loses nothing. Specifically suppose an asset were originally purchased for $1 million and must now be replaced by an equivalent asset costing $3 million. Sup-

pose it were permissible to charge the extra $2 million as an extra depreciation expense during the current year. There would be a savings in taxes amounting to $1,040,000 at the current 52 percent rate. Restoration is not complete as $960,000 would have to be obtained by other means.

To obtain $960,000 on an after tax basis it will be necessary to charge $2 million extra for the products and services of the company.

The government will receive the difference, $1,040,000, as taxes. This is exactly the amount it forgave in taxes in the first place by permitting an extra $2 million allowance for depreciation!

This circumstance prevails regardless of the tax rate.

Depreciation is Only Part of the Problem. An extra allowance for depreciation is more likely to be associated with the replacement problem only. There will be difficulties in practice if an asset is not replaced in kind, and this is true of many assets. The allowance for inflation is not concerned with whether a replacement is made in kind or even not at all.

An extra allowance for depreciation is likely to receive attention in a periodic fashion at such times when replacements are made. The allowance for inflation is always up to date.

An extra allowance for depreciation can be connected only with such assets as can be depreciated. The allowance for inflation embraces all assets that need attention because of inflation.

Deflation. Occasionally a brief period of deflation might occur. The allowance for inflation is calculated as before but the result will be negative indicating an income. This income is on an after tax basis and is probably best handled by transferring it to retained earnings, if possible.

Beginning of Year. The allowance for inflation calculated at the end of the year was given by Equation (1) This equation cannot be used at the beginning of the year because the end of year index is not known at that time.

The allowance for inflation is an expense and it is desirable to know its cost at the beginning of the year so that proper charges can be made for goods and services produced during the year.

The purpose can be achieved by using the indexes for the previous year so that Equation (1) becomes:

$$(ai)'_x = A_{(x-1)} N_{(x-1)} \qquad (2)$$

$$\text{where } N_{(x-1)} = \frac{I_{(x-1)} - I_{(x-2)}}{I_{(x-2)}}$$

Here the symbol $(ai)_x'$ designates the allowance for inflation for the x-th year but available for calculation purposes at the beginning of the year.

This procedure uses the indexes of the previous year, but is not the same thing as being one year behind in the allowance for inflation.

Conclusion. The hidden expense from inflation has been underestimated in the past. The allowance for inflation as presented here is an analysis based on the dollar as a variable, and as such embraces the entire inflation problem.

If no allowance for inflation is made neither the balance sheet nor the income statement can be interpreted properly. Also, profits and return on investment are invariably overstated.

The allowance for inflation is an expense that cannot be ignored. It represents an amount that must be retained after taxes merely to keep even with inflation. It is the cost for standing still. It is the expense incurred merely to prevent a contraction and should never be regarded as funds for expansion.

There is no intention here of discussing the causes of inflation. The dollar is a unit. To define is to make definite and no unit is made definite unless it is defined in terms of quantities that transcend human fancy and caprice. For all practical purposes the dollar is undefined.

The government is the custodian of the various units and through the National Bureau of Standards transmits radio frequencies that are accurate to one part in one hundred million. Paradoxically, the same government as custodian of the dollar allows it to change at a current rate of about 4 percent per year, or *four million* parts per one hundred million per year.

The standard radio frequencies *never* vary as much as the dollar shifts continuously in a matter of seconds!

Note: This article is chiefly a condensation of a book "Allowance for Inflation" © 1959 available from the author.

About the Author

Dr. F. C. Jelen is a licensed professional engineer in New York and has had more than 20 years experience in heavy chemical industries. He received his B.S. and M.S. degrees from Massachusetts Institute of Technology and a Ph.D degree from Harvard University's Graduate School of Arts and Sciences.

LITERATURE CITED

[1] Eng. News Record, 157, No. 22, Dec. 6, 1956.
[2] Peloubet, M. E., Steel, 144, No. 13, March 30, 1959, 54-55.
[3] Terborgh, G., Steel, 144, No. 12, March 23, 1959, 72-73.

Nomenclature

$(ai)_x$ Allowance for inflation for x-th year, calculated at end of x-th year, dollars.
$(ai)_x'$ Allowance for inflation for x-th year, calculated at beginning of x-th year, dollars.
$A_{(x-1)}$ Asset value at beginning of x-th year, dollars.
I_x Numerical value of a cost index at end of x-th year.
N_x The factor $(I_x - I_{(x-1)})/I_{(x-1)}$, used in calculating $(ai)_x$, decimal.
$N_{(x-1)}$ The factor $(I_{(x-1)} - I_{(x-2)})/I_{(x-2)}$, used in calculating $(ai)_x'$, decimal.

These Factors Affect Rate of Return

Here's why a minimum rate of return should not be used as the only criteria when selecting investment projects

Louis P. Karvelas and Dale O. Cooper
Bonner and Moore Engineering Associates
Houston

MANY FACTORS enter the decision to choose desirable projects for investments. An interest rate of return sums up many of these factors into a single number. However, this number for interest rate of return does not include such major factors as risk, management experience, and availability of capital. In fact, the influence of overhead items and income tax is often neglected in the base calculation also.

When comparing projects for investment, it is desirable to include as many factors as possible into a single number, the interest rate of return. Some of the above factors can also be reduced into the single number through statistical or other special analysis. However, many cannot. Consequently, there is no single "magic" number that can always be used to dictate investment policy. In the final decison, there is no substitute for good executive judgment.

The use of a minimum rate of return implies judging a project on its rate of return. If this minimum is used initially to weed out projects from further consideration, then this is tantamount to judging a project solely on its rate of return. As stated above this neglects factors that are not included in a rate of return and as such can lead to poor decisions. If all other factors are considered and the decision rests on the magnitude of the rate of return on the investment then a minimum number may be desirable.

This article will spell out some of the factors entering an investment decision, their potential effect if not considered, and whether it is possible to incorporate them into a single effective rate of return.

Table 1 shows an after tax rate of return on total monies invested for several industries. These figures were derived by calculating the average income after tax and average total money investment (equity and debt) for several companies through the period 1951-57. A simple return was then calculated for each company using this average income and average investment. These company returns were grouped by industry and an average obtained. This should be indicative of the average return to a company on all its investments.

TABLE 1

INDUSTRY	After Tax Return (Percent)
Food	9.2
Steel	10.2
Chemical	10.8
Integrated Oil Company, Domestic	10.9
Integrated Oil Company, World Wide	13.2
Oil Producers, Domestic	16.6

The purpose of this table is to show that a universally acceptable minimum rate of return cannot be used. What may be acceptable to one industry may be too low for another. The difference in rates of return is due primarily to the varying risks of doing business in the various industries. Within a major industry such as the oil industry, the risk of doing business differs between major areas such as production, refining, and marketing to such an extent that the same minimum rate of return would not be acceptable to all three.

NEGLECTED ITEMS

In trying to develop a guide number for a minimum acceptable interest rate of return, a consistent basis and thoroughness of calculation must be maintained. Many articles and books have been written on the various methods of calculating a rate of return.[1,2,3] It is beyond the scope of this article to compare the various methods or to spell out the different costs and incomes that should be included. However, there are several significant factors which are frequently neglected in these calculations. In many cases, a more thorough calculation may show up an unprofitable venture that may otherwise have been accepted.

The effect on the rate of return through omitting some of these factors may best be illustrated by a typical refinery technical service project to reduce corrosion costs in a heat exchanger. Consider a heat exchanger which is now re-tubed annually at a total cost for tubes, labor, and lost production of $23,000. After due corrosion tests and economic calculations, the engineer concludes that special alloy tubes will last four years. The material and installation cost would be $40,000. Expenses over the four years would average $3,000 per year. Then:

Present Annual Cost		$ 23,000
Proposed Project's Annual Cost		— 3,000
Net Savings in Cost	$ 20,000	$ 20,000

Net Increase in Depreciation	—10,000
Net Increase in Taxable Income	$ 10,000
Net Increase in Tax @ 50 percent of Taxable Income	$—5,000
Total After Tax Cash return.	$ 15,000

An interest rate of return before taxes of 35 percent is indicated from these figures and it may be concluded that this is an excellent investment. However, it is easy to end up losing money from such a calculation! Table 2 shows the effect of three items which are often neglected in similar technical-service type projects. A more proper before tax interest rate of return is 21.9 percent based on a four year life. After taxes it may be as low at 8.8 percent. However, some weight must be given to the possibility that the alloy tubes will last only three years. Then the return is zero. (This relates to the element of risk which will be considered in greater detail later.) Consequently, it may not be a wise investment.

Income tax and overhead are two other items usually omitted. The rate of return of a project should be reported on an after tax basis. Projects with similar before tax rates of return may have different after tax rates of return because of such factors as allowable depreciation (rapid amortization versus straight line when allowed by the government), depletion, interest, etc. Since the after tax income is what the company will realize, the rates of return should include the effects of income tax. It should be noted that, if the incremental tax is 50 percent, the after tax rate of return is not half of the before tax rate of return.

TABLE 2—Influence of Neglected Items on Interest Rate of Return

BASIS	Life of Tubes, Yr.	Overhead Considered?	Income Tax Considered?	Interest Rate of Return Percent
All items included	4	Yes	Yes	8.8
Omission 1	4	No	Yes	18.6
Omission 2	4	Yes	No	21.9
Omission 3 (Both 1 & 2)	4	No	No	35.0
Influence of Tube Life				
All items included	3	Yes	Yes	0
Omission 3	3	No	No	21.4

TABLE 3

YEARS	PROJECT A		PROJECT B		PROJECT A & B	
	Inv.	Inc.*	Inv.	Inc.*	Inv.	Inc.*
0	$8000	.....	$1000	.....	$9000	.....
1	....	$ 500	....	$551	....	$1051
2	....	1000	....	551	....	1551
3	1000	2000	....	....	(a)	2000
4	....	2500	....	....	....	2500
5	....	3000	....	....	....	3000
6	....	2500	....	....	....	2500
7	....	2000	....	....	....	2000
8	....	2000	....	....	....	2000
9	....	2000	....	....	....	2000
10	....	2000	....	....	....	2000
Interest Rate of Return After Taxes (percent)	....	16.1	....	6.7	....	17.5

* After Taxes.
(a) The $1,000 needed as investment in the third year for Project A, in the combined case, would come from the regeneration of the $1,000 at the termination of Project B after two years.

Overhead. Many rationalizations are advanced for omitting overhead. However, the inescapable fact remains that overhead is incurred by every project, although not necessarily to the same degree. The simple fact that the technical service engineer evaluating the project is part of overhead, proves this. The technical service time should be the minimum overhead allocated. The significance on the rate of return of not including overhead in the above example is shown in Table 2. In many companies, overhead is allocated to various projects on some formula basis. Although this may not reflect the actual overhead incurred, it has the advantage of simplicity in including the influence of overhead.

Once the factors included in the calculation of a rate of return are standardized, we have taken a step toward the use of a minimum rate of return as a method of accepting or rejecting projects. However, there are certain critical factors not accounted for by any of the present methods of calculating returns.

EFFECT OF MARKETS

The interest rate of return calculation, through the consideration of economic life (duration of the project) does include the factor of project obsolescence. However, the factors of type of market and degree of certainty in the market prediction of both volume and price are not included. To compare two projects, or to compare a project with a minimum or standard rate of return, these factors must be weighted and included.

There are several major classifications of markets: a new market created by a new product (polyester fibers when first introduced); an existing market with similar competitive products (gasoline): a captive market (production of ethylene for use in polyethylene when the latter is also made by the same company); and a contract market. There is a large difference from one

Factors entering the investment decision that affect calculation of a rate of return . . .

- **Cannot include—**
  - Management's and organization's know-how and experience
  - Competitive situation
  - Political climate
  - Capital availability
  - Labor situation
  - Objectivity of calculator
- **Should include through statistical analysis—**
  - Confidence in price and volume predictions, and
  - Confidence in process design
- **Often erroneously omit—**
  - Overhead
  - Tax effects

of these classifications to the next in the confidence of the prediction of sales volumes and prices.

In making a market prediction certain questions are raised. Some of these are:

1. What are the competing products?
2. How much improvement do they need to be equal or better than our product?
3. What is the capacity for production of this product in the country, or in our area?
4. How easy can others enter into the production of this product?
5. Is this a necessity item or a luxury item?
6. If a captive market, what is the ultimate product potential?

The confidence in market predictions is related to the answers to these questions. Thus, if they can be evaluated and weighted relative to some standard scale, then this weighted figure can be used to incorporate the factor of confidence in market prediction in a rate of return figure. (A method of weighting such "Intangible factors" is given in "Introduction to Operations Research").[4]

The following example illustrates the pitfall in using a minimum standard rate of return when the confidence in market prediction is not included in some way. Product A in pre-installation economics showed a rate of return of 36 percent after taxes. The market for this product was an established market where demand had outstripped supply. Other producers could enter this market easily. Product B in pre-installation economics showed a rate of return of 22.5 percent after taxes. The market for this product was on a contract basis, and because of the newness of the process, entry into the market was restricted. In comparing these projects on a rate of return, Product A would appear to be the better project. In actuality, however, other producers entered the market and the rate of return after taxes for Product A dropped to 10 percent, whereas Product B stayed the same. Thus, by overlooking the confidence level in market prediction, a wrong decision could result if the rate of return were the sole criterion for judgment.

EFFECT OF PROCESS

The use of a rate of return as a basis of minimum acceptance of a project does not reflect the risk involved in a new process versus a proven process. A high confidence level would exist in the plant cost and in the process yields for a demonstrated commercial process. On the other hand, the confidence in plant cost and process yields of a process that was only demonstrated on a research bench scale or pilot plant scale would understandably be lower. At times, because of the advantage of being first in a market, a process may not be sent through a complete development cycle. The rate of return for the project should reflect this greater uncertainty in the process.

An example may serve to illustrate this point. Product C had a rate of return of 29.5 percent after taxes. The process was new and process design was based on partial pilot plant study. After the installation of this project, the predicted yields and qualities of products could not be obtained unless the process was changed. The required process changes increased plant cost by one million dollars. The rate of return dropped to 22 percent after taxes as a result of this. If this project were initially compared, solely on a rate of return to another project based on a proven process with a 25 percent rate of return, it may have been selected over the latter. This would have been the wrong decision all other factors being constant. Furthermore, if the investment had been overestimated on Product C, its rate of return may have fallen below a minimum rate of return and thus not been accepted, whereas its true rate of return may have been above this minimum.

A statistical approach may be used to incorporate the confidence in the plant costs into an effective rate of return. Historical correlations from several projects of predicted yields and product qualities (the basis for plant costs) at the various process development stages to the yields and product qualities at the final commercial stage can be obtained. These correlations could then be used to develop weighted factors reflecting the confidence in predicted yields and product qualities at various stages of process development with a standard factor of 100 percent for a proven commercial process. These weighted factors (reflecting the stage of process development) times the plant cost would then give an effective plant cost which could be used to develop an effective rate of return.

EFFECT OF COMPETITIVE SITUATION

In some cases an investment is made because the competitive situation dictates it if the company wants to maintain its position in the industry, to protect existing investment, or increase the ability to sell

About the Authors

Karvelas Cooper

Louis P. Karvelas is a junior partner with Bonner & Moore, Engineering Associates, Houston, where he handles consulting services in connection with operations research and economic evaluations. Holder of a B.S. degree in business and engineering administration from M.I.T. and a M.B.A. degree from Harvard University, he was previously with Humble Oil & Refining Co. There, he worked with the economic evaluation and process design of petrochemical projects, developing cost calculation and economic analysis methods.

Dale O. Cooper is a junior partner with Bonner & Moore, Engineering Associates, Houston, where he handles consulting services in connection with operations research and economic evaluations. Holder of a B.S. degree in chemical engineering and a M.S. degree in chemical engineering practice from M.I.T. he was previously with Union Oil Co. of Calif. There, he was in the Process department, where he handled plant trouble-shooting studies, corrosion studies, process design calculations and detailed economic and operations research studies.

other products. Some examples of this are projects to increase quality of gasoline, increase the purity of a product, and provide a complimentary product for a selling line. Although the project itself may have a rate of return below a minimum rate of return, it cannot be discarded because of its effect on other projects. For example, many reformers have been built which would show a loss on a standard calculation basis. However, losses may be much greater if the refinery failed to maintain competitive product quality.

EFFECT OF CAPITAL AVAILABILITY

With a limited capital availability (an underlying assumption in the use of a minimum rate of return above zero) the total capital required by a project must be considered. A project may have to be delayed or rejected although it is well above a minimum rate of return because of the lack of capital to finance it, whereas a project of lower return may require less capital and be financeable. This consideration cannot be incorporated in a rate of return.

Tied in with the amount of capital required is the duration of the capital requirement. There may be a period in which a company has capital for investment but no project with a rate of return greater than some minimum figure. In such a case, it would be better to invest the capital in some project of below average rate of return, but of short duration of time, rather than having it idle. The following hypothetical example may serve to illustrate this point.

Project A with an expected life of 10 years requires a total investment of $9,000, the major part of which is required immediately and the rest required three years after the start of the project. Project B with an expected life of 2 years requires a $1,000 investment. Table 3 shows the after tax income and the interest rate of return for Projects A, B, and the two combined. Project B alone may have been rejected of what would have been idle capital without being detrimental to Project A, the rate of return on the total capital invested in both projects is greater than either one of the individual rate of returns.

EFFECT OF INTANGIBLE FACTORS

There are certain intangible factors that must be considered by management in making a decision that are not and cannot be included in a single rate of return figure. The first of these would be an evaluation of the person or persons who have compiled the figures. That is, in past work has this person been optimistic or conservative in his assumptions and predictions in working out problems. If two persons evaluated the same project independently, the rate of return they calculate may differ by several percent. Thus one rate of return could be above a minimum rate of return and the other below even though it is the same project. The manager, therefore, must consider the past work of the person evaluating the project to correctly appraise the rate of return.

Another *"intangible factor"* that must be considered is the political climate and its effect on government intervention. The stability of foreign governments, the nationalism exhibited by foreign groups, the lobbying pressures by different groups on our own governments both local and federal, and the results of various elections are all factors that must be evaluated. Their effect on profitability of a project can be drastic. However, this factor cannot be included in a rate of return calculation. Several excellent and recent examples exist. The recent mandatory import restriction drastically affected projects based on foreign crudes to the point where some with previously excellent rates of return became obsolete. At present there is a political drive to reduce depletion allowances. Management's evaluation of the strength behind this drive will be a major factor in the amount of a capital invested in crude oil exploration and production. The recent change in tax by the Venezuelan government has affected projects based on Venezuelan crude.

The availability, qualification, and organizational strength of labor is a factor considered by management. To a certain extent this is reflected in the labor costs shown in the project. However, all the effects cannot be included. As an example, the decision in favor of a project may be made on the basis of creating jobs in an area where there is excess labor although other projects may have higher rates of return. This factor cannot be included in a rate of return.

A very important intangible factor is management's experience and know-how. The previous experience in a particular field will definitely influence the decision of whether or not to accept a project in a similar field. If a previous project has failed management may tend to apply an automatic discount factor to rates of return, for similar projects. This may occur subconsciously. On the other hand, if management has been previously successful in a particular field, they may more readily accept a similar project. Lastly, if the experience in a particular field has been rather limited then management may tend to be more conservative in their thinking and consequently demand a higher rate of return than normal. This thinking cannot be incorporated in a minimum rate of return figure, yet it may be decisive.

In the area of know-how a project must be examined in terms of whether the organization has had experience in this area or in a similar area. The cost of obtaining this experience, if not available internally, is often omitted in project economics, and yet the project may be unsuccessful without it. As an example, a refiner dealing solely in fuel products may have a project for a petrochemical. One of his concerns should be if he has the proper sales organization and if not, can he get it and what will it cost. The availability or non-availability of this organizational know-how cannot be incorporated in a rate of return, but may make the difference in accepting or rejecting a project even though it may have a rate of return above some minimum.

LITERATURE CITED

[1] Weaver, J. B., & Rielly, R. J., Chemical Eng. Progress, Vol. 52, No. 10, Page 405, (October 1956).
[2] Bates, A. G., & Weaver, J. B., Chemical Week, Page 116, June 15, 1957.
[3] Grant, Eugene L., "Principles of Engineering Economy" (New York: Ronald Press Company, 1950).
[4] Churchman, C. W., Ackoff, R. L. & Arnoff, E. L., "Introduction to Operations Research" (New York: John Wiley & Sons, Inc., 1957).
[5] Buell, Warren H., Chemical Engineering, May 1954.

How Du Pont Saves Money with Models

By using larger scale models and more vendor drawings, Du Pont has been successful in saving time and money on design, engineering and construction

Lee A. Myers
E. I. du Pont de Nemours & Company, Inc., Wilmington, Del.

APPLICATIONS OF MODELS has, in general, been as a design aid for arrangement of plants, equipment, and piping. The models employed have included study or layout models, preliminary or piping layout models, and final or piping arrangement models.

The proper use of models gives a better arranged and more economical plant design in shorter time with lower engineering cost.

The ways in which these economies have been accomplished are:

1. Communication between the design section and the client is greatly improved.
2. Studies of arrangements and alternates can be accomplished in less time and cost.
3. Agreement on arrangement and facilities can be firmed at an earlier date.
4. Convincing the client of improved arrangement and reductions in investment is facilitated by the model presentation method.
5. Perodic review by the client, which includes technical, operating and maintenance personnel, as model progresses, results in fewer late revisions to design.
6. Communications between Design Sections: process, power, structural, electrical, etc., are improved and space allocated much easier with minimum interference.

The foregoing is based on the concept that models are a design tool, principally for aid in producing the required drawings for equipment and piping arrangement. This has been the conventional use of models.

Extension of the use of models, such as a training aid for operators, an orientation aid for construction personnel and maintenance analysis have, of course, been done to more or less extent by many users of models.

Others have tried and have been more or less successful with model photography as an aid in producing drawings which combine reproduced photographs with drawing dimensions and details. In some cases, piping fabrication sketches have been made directly from the model.

An analysis of further extension of the use of models as design aids results in these possibilities:

1. Arrangement of instrument, valves and components, instrument trays and lines.
2. Electrical conduit trays, miscellaneous control equipment, and lighting arrangement.
3. Heating and ventilating equipment and duct arrangement.
4. Intricate plumbing and service piping arrangement particularly for laboratory-type installations.

The ultimate step in the application of models is to utilize them to transmit information to the field construction forces thereby eliminating a major portion of the process and power piping, instrumentation, electrical, and heating and ventilating arrangement drawings.

At Du Pont all of the foregoing uses of models are being practiced. The acceptance of the use of the "field transmittal model" which serves in lieu of many of the arrangement drawings has been

brought about over a period of time with many questions being resolved both in the matter of the method of making the model and in the means of record of the design as transmitted.

Sufficient supplemental drawings, vendors' prints, diagrams, schematics, maps, standards and specifications are sent to the field construction forces with the model such that the total information transmitted to the field is equivalent to that transmitted by the conventional drawing method. This supplemental information includes details of any congested or critical areas which may not be in sufficient detail on the model due to scale limitations.

Interference. For the portions of the work which are covered by conventional drawings, the model represents this only to the extent that interference may be involved, or is required for construction planning.

Size and Scale. The scale for most "field transmittal models" has been ¾ inch per foot. This scale is sufficiently large so that all but the most intricate piping details can be shown with sufficient accuracy for construction purposes. A further advantage of this scale is that a craftsman with normal scale or ruler can measure directly on the model since 1/16 inch equals 1 inch.

Individual model table sizes, in general, are limited to a width of 42 inches and length of 72 inches; although, where advantageous and permissible, the size has been as large as 5 feet by 9 feet. For a plant or large process, it becomes necessary to utilize a number of tables which fit together for final assembly.

The intent of the "field transmittal model" includes the following to scale (not necessarily to full detail) in correct location:

Equipment: All equipment including drives.

Process Piping: Include all valves, in-line instruments, vents, drains, sample lines and special support requirements.

Instruments: All instruments not located on panels; panels, cubicles and cabinets; control valves; tubing bundles and conduit over 1 inch; orifice and runs; and trays.

Ductwork: Include dampers and grills.

Service Piping: 1½ inch and larger; smaller where space is critical. (All to same detail as process piping).

Electrical: Starter racks, substations, lighting fixtures, trays and conduit banks, conduit 1½ inch and larger, cubicles and panels, and cables.

Structure: All members to scale (Not necessarily to shape).

Note: Where duplicate facilities with identical piping and services are being installed, only one train will be piped on the model unless critical from interference standpoint.

Photographs. Upon completion of the model, photographs are taken in as many views as to record the design as built into the model. These photographs are reproduced as standard size photo tracings on polyester film base and retained as permanent record. These photographs plus the supplementary information previously mentioned, together with fabrication details made later from the model, constitute sufficient information for reproduction of the model, or as a basis for drawings of the plant at any later date.

Costs. The "Field Transmittal Model" at ¾ inch scale costs somewhat more than the conventional ⅜ inch or ½ inch scale "design aid" model not only due to the size but also due to more detail and accuracy. The cost differential, however, is small in comparison with the drawing time saved on piping, instrumentation, electrical and in many cases heating and ventilation drawings.

Acceptance. So far we have dealt with the benefits in design of the plant. What is the impact of this method of transmittal of design information on the field construction forces?

Open-minded acceptance of a new concept of design information is, of course, a necessity. This has been more easily accomplished than was originally believed possible once the field construction forces evaluate the potential benefits.

A summary of these benefits:

1. More rapid field analysis of design, specifications and job requirements for crafts and better overall project planning.
2. Improved employee orientation.
3. Improved craft-work planning, sequencing, and scheduling.
4. Improved material takeoff, scheduling, and handling.
5. Elimination of construction interferences and "re-do" not normally foreseen on conventional drawing method.
6. Elimination of the change work orders when plant is ready to be turned over to operations, requested for items not on drawings but seen on the model and resolved beforehand.

Savings. Experience to date indicates the savings possibilities in field construction may equal the design savings and that combined savings in design and construction make models well justified. # #

About the Author

Lee A. Myers is design project manager for E. I. du Pont de Nemours & Co.'s Engineering department, Wilmington, where he handles process design development and design-model operation. A professional engineer and holder of a B.S. degree in industrial engineering, Myers worked for Hughes-Cash Engineering Co., Detroit, for a year in electronic design, and was a sales engineer for Johnson Service Co., Milwaukee, for three years. During his many years with Du Pont, he has been in chemical plant operation, industrial engineering as a group head, assistant project engineer, and design project manager, plant design.

Find Air Conditioning Costs Quickly

Here are sufficient data for rapidly estimating the costs for industrial air conditioning systems

N. H. Prater and D. W. Antonacci
The Chemstrand Corporation, Pensacola, Fla.

AIR CONDITIONING is essential in many types of industry to attain the controlled conditions required by the manufacturing processes and to maintain personnel health and efficiency. The cost for providing this service amounts to as much as 4 percent of the total investment in some chemical plants. With a new period of economic growth ahead and a continuing movement of industry to the South, air conditioning has become an increasingly important factor in the design and investment for these new industries. This article presents carefully prepared data for estimating the cost of the more common types of industrial air conditioning systems utilized in the chemical industry today.

Air conditioning is defined as the simultaneous control of temperature, humidity and air motion within an enclosed space. This also involves air cleaning, heating or cooling, humidifying or dehumidifying and distribution of the air. Many types of equipment are available for conditioning air and usually a number of arrangements of systems which will fulfill the functional requirement can be utilized. However, because of the variety of design objectives and differences in buildings encountered, no system can be applied indiscriminately. The relative merits of each system must be evaluated on the basis of investment and operating costs as well as future adequacy and flexibility.

Design Conditions. The primary consideration in selecting an air conditioning system is the cooling load to be handled. This, in turn, depends upon the outside air conditions, physical characteristics of the building, and desired internal conditions. Outside air wet and dry bulb temperatures and wind velocities vary with each geographical

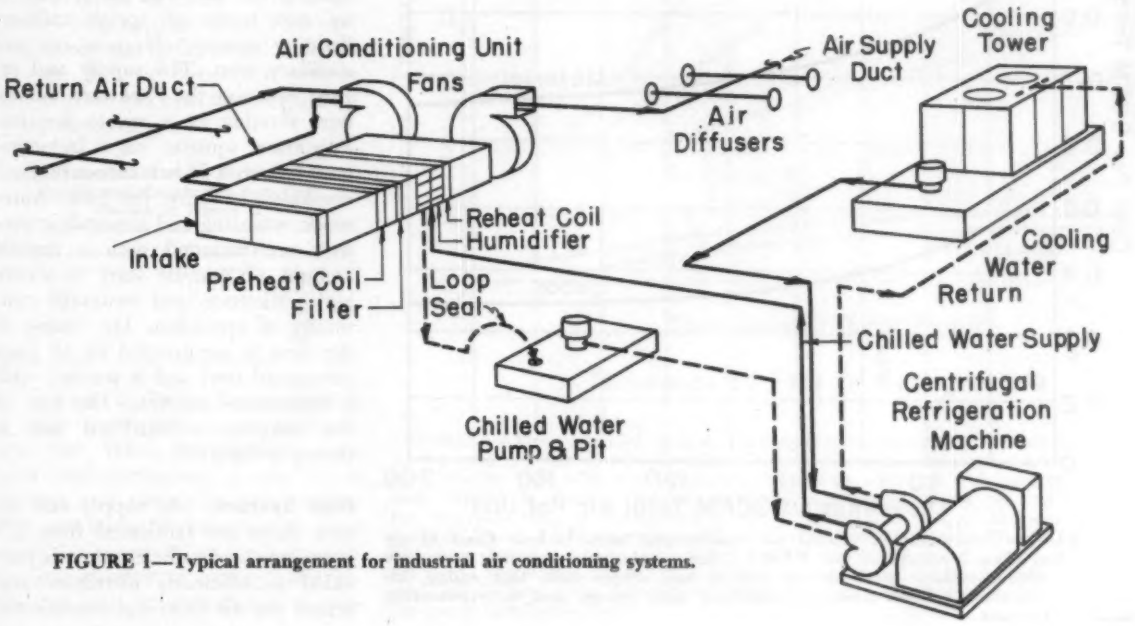


FIGURE 1—Typical arrangement for industrial air conditioning systems.

location and temperatures that are not exceeded more than 5 to 8 percent of the cooling season should be selected as a basis for design. The inside design conditions for comfort cooling depend on the duration of occupancy, contrast between inside and outside temperatures, etc., while design conditions for process requirements are fixed by the performance objectives.

The design conditions for industrial air conditioning must be determined for the particular manufacturing process involved, therefore, general recommendations cannot be made as is done for comfort air conditioning. It is common practice not to supply outside air for ventilation in industrial applications except where toxic gases, smoke or fumes are present and the quantity of outside air is frequently based on State Laws that prevail for the particular location. When fresh air is required for ventilation purposes, the quantity usually depends on the number of occupants, type of activity and the volume of space involved. Recommended outside air requirements for comfort air conditions are shown in Table 1.[3]

TABLE 1—Approximate Fresh Air Requirements for Ventilation

Service	Fresh Air, CFM/Person		Fresh Air, CFM/Sq. Ft. of Floor Area
	Normal	Minimum	
Control Rooms	20	10	...
Board Rooms	50	30	...
Corridors	..	..	0.25
Directors Rooms	50	30	...
Factories	10	7.5	0.10
Garage	..	..	1.0
Office Rooms:			
Private	25	15	0.25
General	15	10	...
Restaurant:			
Kitchen	..	..	4.0
Dining Room	15	12	...
Shops	25	15	...
Locker Rooms	..	..	2.0
Stores	10	7.5	2.0

The System. The analysis of air conditioning requirements for industrial processes is extremely complex and a detailed treatment of this subject is beyond the scope of this article. However, the type of unit most widely accepted in industry is the central air conditioning system and descriptive data and costs for this type are presented here. The major components of the central system include the air conditioning units, supply and return duct systems, centrifugal refrigeration machines, chilled water pumps, cooling tower and the distribution piping system. The principal advantage of this system is that all the equipment is centrally located which simplifies both maintenance and operation. This also eliminates the need for chilled water and steam piping, electrical equipment, and wiring in the conditioned space. In addition, this system can be used to heat or cool without the necessity of seasonal changeovers and provides the desired flexibility to meet specific design and cost objectives. A schematic diagram of this type system is shown in Figure 1.

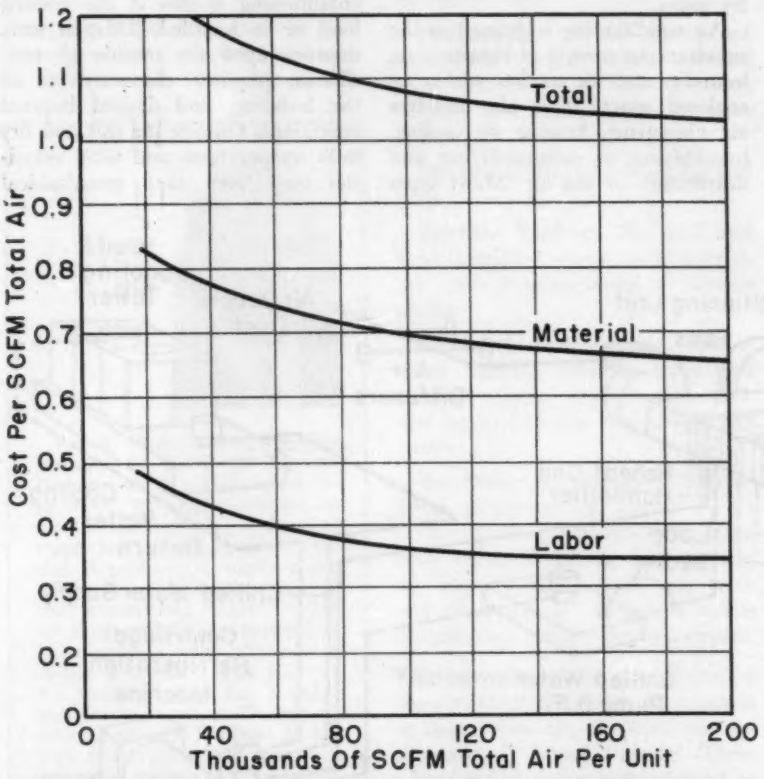


FIGURE 2—These costs of central air conditioning units include Class II air supply fan, Class I return air fan, NEMA I fan motors, motor starters, automatic controls, filters, variable pitch drives, preheat and reheat coils, unit casing, insulation, vibration isolator pads, dehumidifiers with pumps and interconnecting piping at the unit.

Air Handling. The central air conditioning apparatus is a field assembled unit comprising several basic functional elements. The flow of outside air, return air and fan supply air is controlled by opposed leaf multiblade dampers. A viscous self cleaning filter is used for cleaning the air while non-freeze steam coils are used for preheating and reheating the air. The air is washed by two banks of sprays utilizing flooding nozzles, eliminators and auxiliary trim. The supply and return fans are the backward curved type rotating in a volute housing. Polyphase squirrel cage induction motors with a V-belt connection are employed to drive the fans. Automatic actuating and responding controls are included with a limited amount of manual start to secure high efficiency and maintain continuity of operation. The casing of the unit is constructed of 18 gage galvanized steel and is painted with a bituminous solution. The cost of the complete assembled unit is shown in Figure 2.

Duct System. The supply and return ducts are fabricated from 3 S aluminum and sufficient area is provided to efficiently distribute and return the air from the conditioned

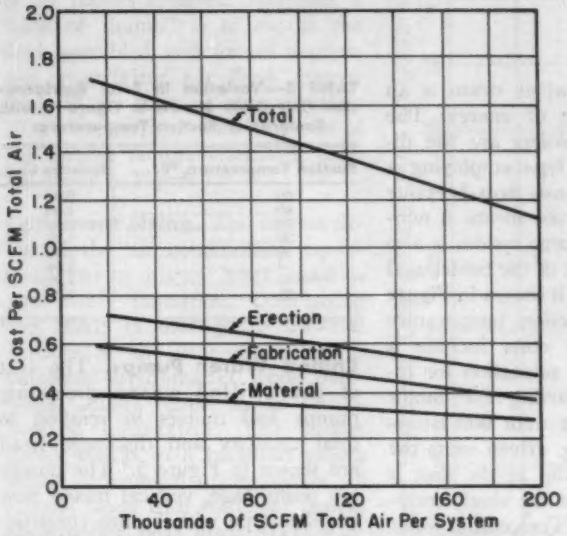


FIGURE 3—Gives the cost of the entire duct system and includes diffusers with damper, turning vanes, hangers, insulation, branch ducts and risers.

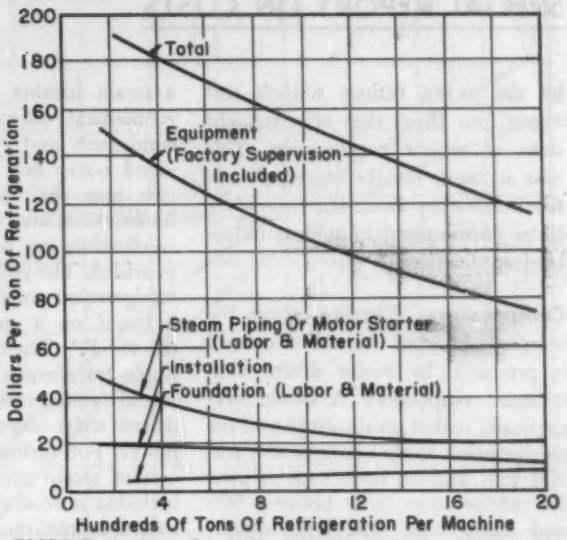


FIGURE 4—Cost of centrifugal refrigeration machines (40°F suction, 108.9°F condensing) includes compressor, turbine or motor drive, shell and tube cooler and condenser, interconnecting cooling and chilled water piping and insulation.

spaces. The main duct is sized for an air velocity of 2,000 feet per minute while each branch duct and riser is limited to velocities of 1,500 and 800 feet per minute, respectively. One outlet and diffuser including a supply damper is included for each 500 square feet of conditioned space. The total air quantity supplied is based on 2.7 cfm per square foot of floor area. The cost of the entire duct system can be estimated from the data shown in Figue 3. Appropriate correction factors are shown in Table 2 for systems utilizing different air rates per square foot of floor area. This correction applies to the situation where the air flow is distributed over a larger floor space while maintaining the same cooling load.

TABLE 2—Effect of Air Flow on Total Supply and Return Air Duct Cost Shown in Figure 3

Air flow scfm sq. ft. floor area	Relative cost
2.70	1.00
2.25	1.15
1.75	1.46
1.25	2.00
0.75	3.00

The cost of the air duct represents a large percentage of the total system cost. When the system is complex and containing a variety of fittings and risers, the total system can cost 60 to 75 percent more than a similar system of simple ducts and limited number of fittings. The increased cost is contributed largely

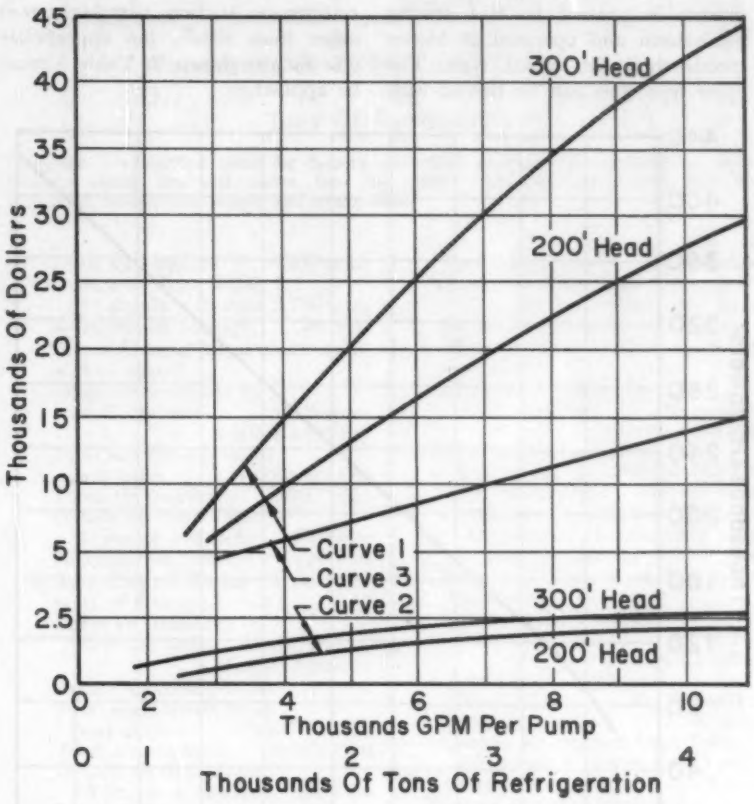


FIGURE 5—These costs for chilled water circulating pumps and motors are based on 2.5 gpm per ton of refrigeration. They also assume multi-stage, vertical mixed flow impeller type with bronze construction pumps equipped with vertical, hollow shaft, NEMA II motors. The cost of 50 feet of electrical wiring and conduit from the unit substation to the motors is also included. The cost of the substation is omitted. Curve 1—Equipment cost, pump with motor. Curve 2—Installation cost including electrical wiring and conduit for one pump and motor; use 57 percent of one pump installation cost for each additional unit. Curve 3—Piping cost, labor and materials for one pump installation; additional pump installation use 75 percent of one pump installation cost.

by the extra fittings which cost about four times that of a straight duct of similar construction. This also accounts for the increased cost for multi-story installations over those encountered in typical industrial applications.

Compressors. Chilled water for temperature and humidity control is produced by motor driven centrifugal compressors. A closed hermetically sealed unit is employed for refrigeration loads between 200 and 900 tons and an open type is used for refrigeration loads between 900 and 2,000 tons. The light weight and smooth operating characteristics of the closed unit eliminate the need for costly foundations and vibration isolators. Usually the open type compressor is geared to the driving mechanism and operated at higher speeds than the closed type. The open type unit can be driven with a steam turbine when steam is an economical source of energy. The condensers and coolers are the divided water box type employing a two pass shell and non-ferrous finned tubes and tube sheets. A non-condensible gas purge system is also provided. The cost of the centrifugal refrigeration units is shown in Figure 4 based on a suction temperature of 40 F.[2] These costs include a single transformer substation for reduced voltage starting for motor driven units larger than 600 horsepower. For turbine driven units the cost of steam piping at the unit is included instead of the single transformer substation. The cooling water and chilled water piping required at the unit and speed increaser, where required, are also included in the total cost for the system. For compressor suction temperatures other than 40 F., the appropriate cost factors shown in Table 3 must be applied.

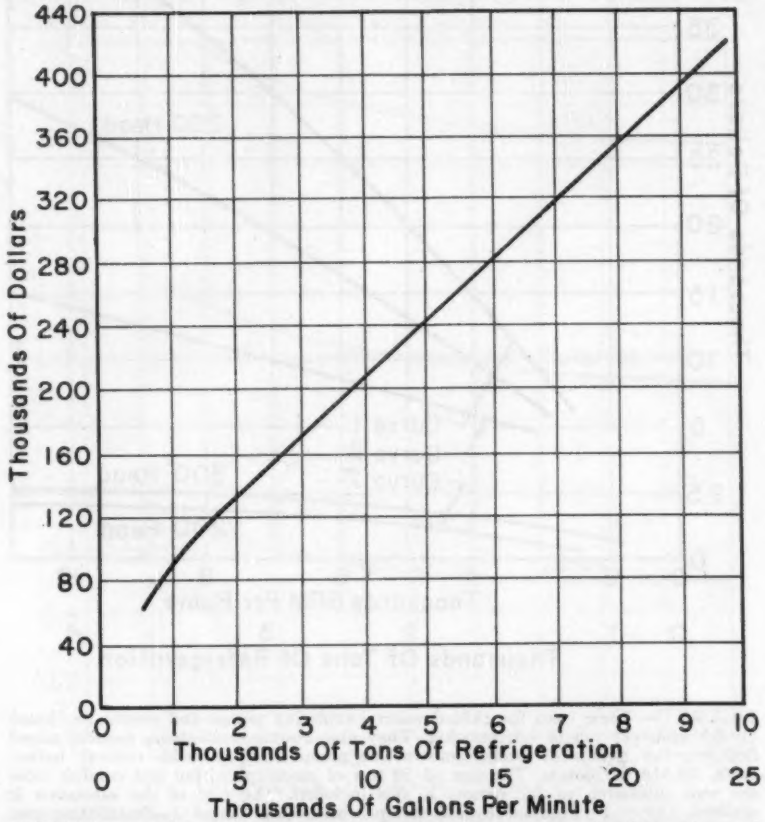


FIGURE 6—Cooling tower cost is based on 2.5 gpm per ton of refrigeration and includes cooling tower cost and erection, fans and motors with installation cost, concrete basin with pump pit and pumps with associated piping. The main cooling water piping leading to and away from the tower is omitted.

TABLE 3—Variation in Total Refrigeration Unit Costs Shown in Figure 4 with Compressor Suction Temperatures

Suction Temperature, °F.	Relative Cost
50	0.94
40	1.00
30	1.08
20	1.20
10	1.42
0	1.64
—10	1.91
—20	2.22

Chilled Water Pumps. The cost of the chilled water circulating pumps and motors in relation to total capacity and discharge head are shown in Figure 5.[1] The pumps are multi-stage, vertical mixed flow impeller type with bronze construction and equipped with vertical, hollow shaft, NEMA II motors. Also included in these costs is 50 feet of electrical wiring and conduit from the unit substation to the motors. The cost of the unit substation, however, is not included.

Cooling Tower. The cooling water for the refrigeration unit condensers is supplied by a cooling tower. The tower is the induced draft, wood filled, wood frame and cased type, of heart redwood construction. The structural framework of the tower including all members and connections are designed to withstand a wind load of 30 pounds per square foot of projected area. The fans are axial flow, multi-blade type constructed of stainless steel. The cooling tower circulating water pumps are vertical type similar to that employed for the chilled water service. The cost of the inter-connecting piping, float valve, pump screen, anti-cavitation plate, drain and overflow connections are included. The main cooling water piping leading to and away from the tower is not included as part of the "battery limits" cost. The cost of the complete cooling tower installation is shown in Figure 6.[1]

There are many instances where the air conditioning load is not sufficiently high to justify the use of the larger field assembled units. For these applications, smaller factory assembled units are employed. The operating range of both types overlap somewhat and the final selection of the system to be employed must be based on an economic analysis

of all factors involved. However, a "rule of thumb" is to choose the field assembled unit for all application requiring air flows greater than 20,000 scfm or approximately 70 tons of refrigeration. The cost of the smaller factory assembled units are shown in Figure 7.

Equipment Sizing. The correct sizing of the air conditioning equipment for a given heat load is extremely important. Undersizing can result in damage to the end product of the process as well as personnel discomfort while oversizing usually results in an uneconomical operation. The proper choice results in a balanced system giving economical operation for all normal loads with sufficient reserve for expected peak loads. Having arrived at the correct size of the components in the system, the next step is to estimate the cost of the proposed installation. This following example illustrates how the data presented in Figures 2 through 7 are used to arrive at the total system cost.

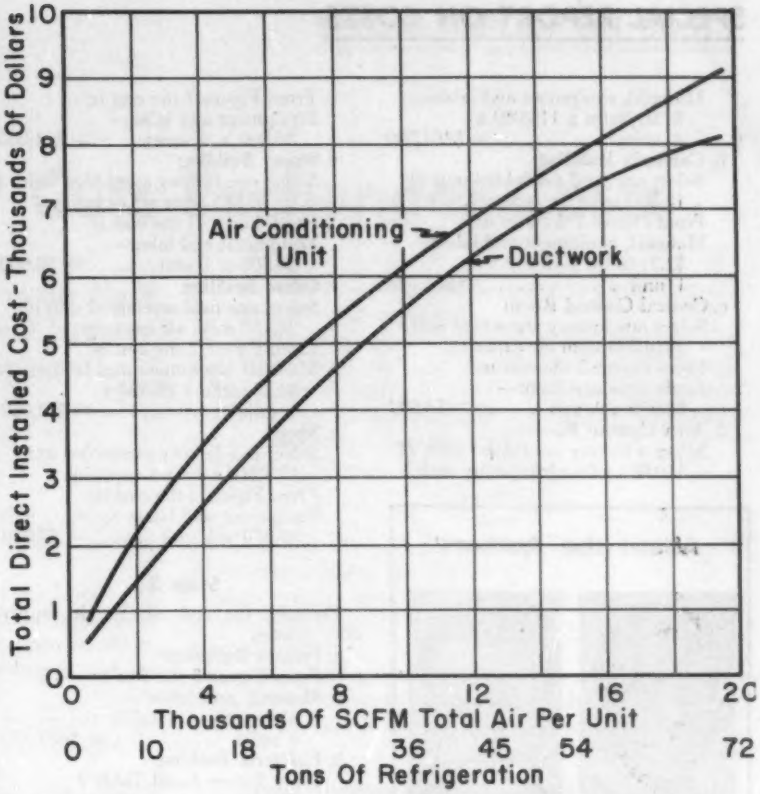


FIGURE 7—Installed costs for factory assembled package air conditioning units includes casing, fan with motor, four row cooling coil, one row heating coil, V-type filter, damper and supply and return duct.

Example

Estimate the total direct installed cost of an air conditioning installation for a typical industrial plant. The conditioned spaces include four process buildings, cafeteria, five control rooms, stores building, general offices and maintenance shops. The outside air design conditions are based on a 95 F. dry bulg and 82 F. wet bulb temperature.

Step 1

Determine the total refrigeration tonnage and air quantities required for each conditioned area.

a. **Process Buildings** (4 @ 40,750 sq. ft. of floor space each)
Inside air conditions are 76 F. dry bulb temperature with 70 percent relative humidity.
Basis: One building
Total sensible and latent heat gains.....14.16 million Btu/hr.
Total air required....110,000 scfm
Outside air @ 10 percent .....11,000 scfm
Refrigeration tonnage ..1,180 tons
Total refrigeration all process buildings .....4,720 tons

b. **Cafeteria Building** (7,500 sq. ft. of floor space)
Inside air conditions @ 76 F. dry bulb.....60 percent relative humidity
Total sensible and latent heat gains.....792,816 Btu/hr.
Total air required....18,800 scfm
Outside air from Table 1: 250 people x 15 scfm.3,750 scfm
Refrigeration tonnage.....66 tons

c. **Central Control Room** (3,000 sq. ft. of floor space)
Inside air conditions @ 76 F. dry bulb.....60 percent relative humidity
Total sensible and latent heat gains.....316,280 Btu/hr.
Total air required....18,800 scfm
Outside air from Table 1: 20 people x 20 scfm...400 scfm
Refrigeration tonnage.....26 tons

d. **Area Control Rooms** (4 @ 1,500 sq. ft. of floor space each)
Inside air conditions @ 76 F. dry bulb.....60 percent relative humidity
Basis: One control room
Total sensible and latent heat gains.....185,950 Btu/hr.
Total air required....10,685 scfm
Outside air from Table 1: 10 people x 20 scfm...200 scfm
Refrigeration tonnage.....15 tons
Total refrigeration all control rooms.....60 tons

e. **Stores Building** (3,000 sq. ft. of floor space)
Inside air conditions @ 76 F. dry bulb.....60 percent relative humidity
Total sensible heat gains .....217,375 Btu/hr.
Total air required....10,865 scfm
Outside air from Table 1: 25 people x 10 scfm...250 scfm
Refrigeration tonnage.....18 tons

f. **Office Building** (26,000 sq. ft. of floor space)
Inside air conditions @ 76 F. dry bulb.....60 percent relative humidity
Total sensible and latent heat gains.....955,600 Btu/hr.
Total air required....26,450 scfm
Outside air required from Table 1: 300 people x 20 scfm.6,000 scfm
Refrigeration tonnage.....80 tons

g. **Shops** (2,000 sq. ft. of floor space conditioned)
Inside air conditions @ 76 F. dry bulb.....60 percent relative humidity
Total sensible and latent heat gains.....90,420 Btu/hr.
Total air required.....3,560 scfm
Outside air required from Table 1: 15 people x 25 scfm...375 scfm
Refrigeration tonnage.....8 tons

Total refrigeration tonnage for all systems..... = 4,978 tons

Step 2

Estimate the cost of both factory and field assembled air conditioning units.

a. **Process Buildings**
Select 4 field assembled units at 110,000 scfm air capacity each.
From Figure 2 the cost is:

Material, equipment and labor—
$1.05/scfm x 110,000 x
4 units ..... = $462,000

b. **Cafeteria Building**
Select one field assembled unit @ 18,800 scfm air capacity.
From Figure 2 the cost is:
Material, equipment and labor—
$1.31/scfm x 18,800 x
1 unit ..... = $24,628

c. **Central Control Room**
Select one factory assembled unit @18,800 scfm air capacity.
From Figure 7 the cost is:
Equipment and labor—
$8,900 x 1 unit..... = $8,900

d. **Area Control Rooms**
Select 4 factory assembled units @ $10,685 scfm air capacity each.
From Figure 7 the cost is:
Equipment and labor—
$6,000 x 4 units..... = $24,000

e. **Stores Building**
Select one factory assembled unit @ 10,685 scfm air capacity.
From Figure 7 the cost is:
Equipment and labor—
$6,000 x 1 unit..... = $6,000

f. **Office Building**
Select one field assembled unit @ 26,450 scfm air capacity.
From Figure 2 the cost is:
Material, equipment and labor—
$1.25/scfm x 26,450 x
1 unit ..... = $33,062

g. **Shops**
Select one factory assembled unit @ 3,560 scfm air capacity.
From Figure 7 the cost is:
Equipment and labor—
$3,050 x 1 unit..... = $3,050

Step 3

Estimate the cost of the air supply duct system.

a. **Process Buildings**
From Figure 3 the cost is:
Material and labor—
$1.41/scfm x 110,000 x
4 units ..... = $620,400

b. **Cafeteria Building**
From Figure 3 and Table 2 the cost is:
Material and labor—
1.1 x $1.71/scfm x
18,800 x 1 unit..... = $35,398

c. **Central Control Room**
From Figure 7 the cost is:
Ductwork (complete)—
$8,000 x 1 unit..... = $8,000

d. **Area Control Rooms**
From Figure 7 the cost is:
Ductwork (complete)—
$5,500 x 4 units..... = $22,000

e. **Stores Building**
From Figure 7 the cost is:
Ductwork (complete)—
$5,500 x 1 unit..... = $5,500

f. **Office Building**
From Figure 3 and Table 2 the cost is:
Material and labor—
2.3 x $1.68/scfm x
26,450 x 1 unit..... = $102,203

g. **Shops**
From Figure 7 the cost is:
Ductwork (complete)—
$2,200 x 1 unit..... = $2,200

Step 4

Estimate the cost of the return air duct system.

a. **Process Building**
From Figure 3 and Table 2 the cost is:
Material and labor—
$1.41/scfm x 99,000 x
4 units ..... = $558,360

b. **Cafeteria Building**
From Figure 3 and Table 2 the cost is:
Material and labor—
1.1 x $1.71/scfm x
15,050 x 1 unit..... = $28,308

f. **Office Building**
From Figure 3 and Table 2 the cost is:
Material and labor—
2.3 x $1.68/scfm x
20,450 x 1 unit..... = $79,018

Since the factory assembled units are small and the ductwork is not extensive, total duct costs for these systems are included in the supply duct costs shown in Step 2.

Step 5

Estimate the cost of the central refrigeration machine.
Select 4 motor driven units @ 1,250 tons/hr. capacity each.
From Figure 4 the cost is:
Equipment, motor starters, installation and foundations—
$140/ton x 1,250 tons x
4 units ..... = $700,000

Step 6

Estimate the cost of the chilled water pumps:
Circulation rate—2.5 gpm/ton or a total circulation of:
2.5 x 1,250 tons x
4 units ..... = 12,500 gpm
Select 4—3,200 gpm pumps @ 200 feet head
From Figure 5 the cost is:
Pump and motor—
$7,000 x 4 units..... = $28,000
Piping—$4,950 x 1 unit +
$4,950 x 0.75 x 3 units. = $16,087
Installation—$800 x 1 unit +
$800 x 0.57 x 3 units....= $ 2,168

Step 7

Estimate the cost of the cooling tower system.
Circulation rate—2.5 gpm/ton or a total circulation of:
2.5 x 1,250 tons x
4 units ..... = 12,500 gpm
From Figure 6 the total direct installed cost of the complete tower is..... = $240,000

Total direct cost of the complete air conditioning system ... = $3,009,282
Cost per ton..... = $605

The costs presented here do not include electrical equipment, conduit, and piping outside the "battery limits" of the central system. In addition, building costs required to house the system are omitted since the type and scope will vary depending on the specific conditions involved. Similarly, overhead charges must be added to obtain the final installed cost of a complete system.

LITERATURE CITED

[1] N. H. Prater and D. W. Antonacci, "How to Estimate Cooling Tower Costs," PETROLEUM REFINER, 38, No. 4, p. 119, 1959.
[2] Robertson, James T., "How to Select Refrigeration Equipment," PETROLEUM REFINER, 38, No. 2 115-122, 1959.
[3] ASHAE, Heating, Ventilating, Air Conditioning Guide, p. 285, 1956.

About the Authors

Antonacci

Prater

D. W. Antonacci is a design engineer for The Chemstrand Corp., Pensacola, Fla., where he handles the design of utility and services facilities. Holder of a B.S. degree in mechanical engineering from Tri-State College, he was previously with Dravo Corp. as an engineer, construction engineer, mechanical superintendent, construction superintendent and assistant project manager for the design and construction of power plants, water treating plants, oil pumping stations, etc. A registered mechanical engineer, he has been with Chemstrand since 1955.

N. H. Prater is a senior design engineer with The Chemstrand Corp., Pensacola, Fla., where he handles design of new facilities and project engineering. Holder of a B.S. degree in chemical engineering from Georgia Institute of Technology, he previously worked for Magnolia Petroleum Co., Beaumont, Texas, doing design work in distillation, economic evaluations, and scheduling refinery operations. He has written other excellent articles for PETROLEUM REFINER.

Optimum ΔP Cuts Exchanger Costs

Economic evaluation shows in many cases that reduced exchanger cost will be more than offset by increased pumping

William J. Baker
The Lummus Company, Houston

A FREQUENT PROBLEM confronting process engineers is how much pressure drop to specify in heat exchangers.

Increased pressure drop—*properly applied*—can reduce the exchanger size and cost as well as improve its operation. Pumping cost increases with pressure drop, there the optimum—lowest capital investment and favorable operating cost—must be found.

When the velocity of a stream in an exchanger is increased the following beneficial results are obtained:

- The heat transfer rate is improved.
- Less surface and possibly a smaller exchanger is required.
- Less plot plan area and structural cost.
- Increased length of time between cleaning operation.

The basic equations for heat transfer by convection:

- Liquids heated or cooled inside of tubes—

$$hi = \frac{k}{D}\phi \left(\frac{DG}{\mu}\right)^{.8} \left(\frac{C\mu}{k}\right)^{.33} \left(\frac{\mu a}{\mu w}\right)^{.14}$$

- Liquids heated or cooled outside of tubes (shell side)—

$$ho = \frac{k}{D}\phi \left(\frac{DeG}{\mu}\right)^{.55} \left(\frac{C\mu}{k}\right)^{.33} \left(\frac{\mu a}{\mu w}\right)^{.14}$$

From these basic equations we see that the heat transfer rate is effected as follows:

The tube side rate will change as the mass velocity to the 0.8 power ($G_t^{.8}$). The shell side rate will change as the mass velocity to the 0.55 power ($G_s^{.55}$). Assuming in any given exchanger that all other conditions remain unchanged (see Figure 1).

The basic pressure drop equation

$$\Delta P = \frac{4f\rho G^2 N}{2gD}$$

indicates that the pressure loss will vary as the square of the mass velocity (see Figure 1).

Since density and physical dimensions are constant in each consideration the same relation may be referred to linear velocity.

The principle concerned here involves liquid streams being heated or cooled where the Reynolds number exceeds 2,100, and where no change of phase takes place.

TABLE 1—Effect of Pressure Drop on an Oil Cooler

Example	A	B	C	D	E	F	G	H
Shell side pressure drop, psi	5	10	15	5	10	15	....	.....
Tube side pressure drop, psi	....	....	....	....	....	....	5	15
Tube side water rate, h_t = 1,000	.0010	.0010	.0010	.0010	.0010	.0010	.001	.00055
Tube side fouling rate	....	....	....	....	....	....	.002	.002
Total tube side resistance	....	....	....	....	....	....	.003	.00255
Shell side oil rate	.0075	.0062	.0055	.0075	.0062	.0055	.0075	.0075
Shell side fouling factor	....	....	....	....	....	....	.0020	.0020
Tube side resistance referred to outside surface .003 x 3.5 =	....	....	....	....	....	....	.0105	.0089
Total fouling factor	.0040	.0040	.0040	.0020	.0020	.0020	....	....
Total resistance	.0125	.0112	.0105	.0105	.0092	.0085	.0260	.0184
Overall heat transfer rate "U"	80	89	95	95.5	108.5	117.5	50	54.5
Percent less surface required	....	10	16	....	12	19	....	9

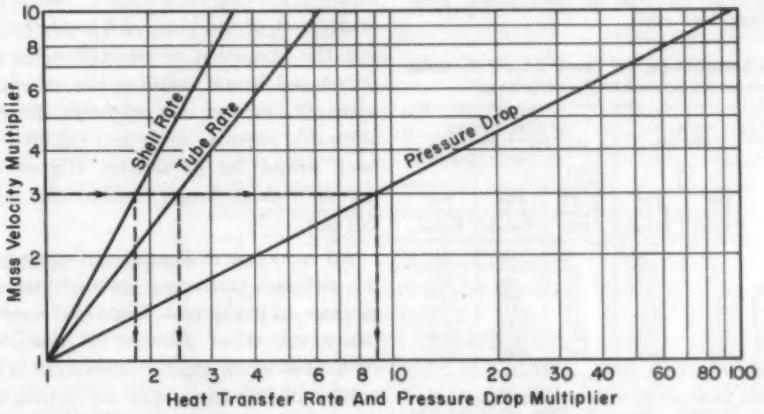


FIGURE 1—Shows how transfer rate varies with pressure drop. For example: If mass velocity is increased three times the original value, pressure drop will increase approximately nine times, shell rate multiplier is 1.8 and tube rate multiplier is 2.4.

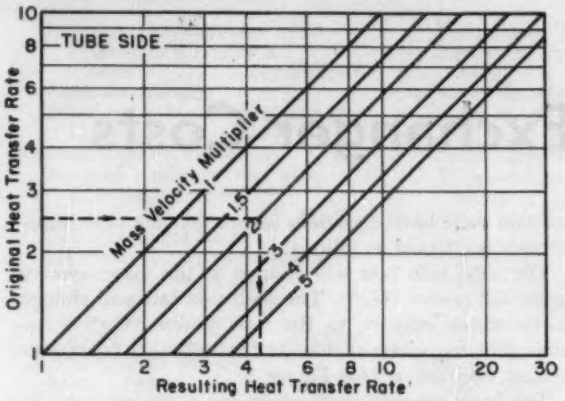


FIGURE 2—Here's what happens to tube side rate when velocity is doubled. For example: Using mass velocity multiplier from Figure 1, if original velocity having rate of 25 Btu/hr/sq ft were doubled, new rate would be 44 Btu/hr/sq ft or h_t or 250 will increase to 440.

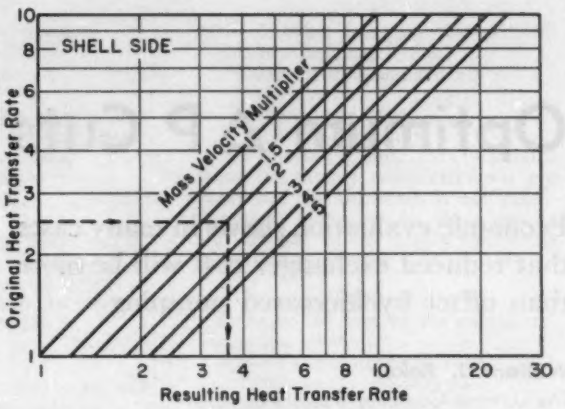


FIGURE 3—Tube side multipliers from Figure 1 show this effect when velocity is doubled. Shell rate of 25 Btu/hr/sq ft when velocity is doubled gives rate of 36 Btu/hr/sq ft or h_s of 250 will increase to 360.

The most advantage is gained where one stream represents more than half of the over-all resistance.

For example, notice the data for an oil cooler as shown in Table 1.

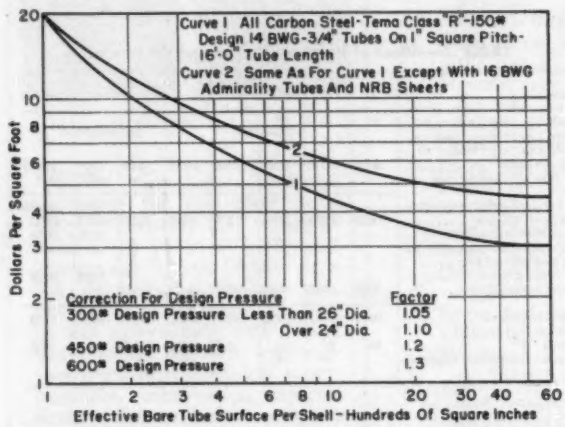

Curve 1 All Carbon Steel-Tema Class "R"-150# Design 14 BWG-3/4" Tubes On 1" Square Pitch-16'-0" Tube Length
Curve 2 Same As For Curve 1 Except With 16 BWG Admiralty Tubes And NRB Sheets
Dollars Per Square Foot
Correction For Design Pressure
300# Design Pressure Less Than 26" Dia. 1.05
Over 24" Dia. 1.10
450# Design Pressure 1.2
600# Design Pressure 1.3
Factor
Effective Bare Tube Surface Per Shell - Hundreds Of Square Inches

FIGURE 4—Two different materials of construction show these approximate square foot costs.

TABLE 2—Approximate Surface—Sq. Ft. (Bare Tubes) In TEMA Type "R" Exchangers Removable Floating Head

Size Nominal Shell Dia. (Inches)	¾" O.D. TUBES ON 1" □ PITCH			¾" O.D. TUBES ON 15/16" △ PITCH		
	For One (1) Ft. Tube Lgth.	For 16 Ft. Tubes	For 20 Ft. Tubes	For One (1) Ft. Tube Lgth.	For 16 Ft. Tubes	For 20 Ft. Tubes
8	5	80	100	7	112	140
12	14	224	280	18	288	360
16	25	400	500	33	528	660
20	42	672	840	55	880	1100
24	62	1000	1250	82	1310	1640
30	100	1600	2000	132	2105	2640
36	150	2400	3000	200	3200	4000
43	220	3520	4400	290	4640	5800
	For 1" O.D. Tubes on 1¼" □ Pitch Multiply The Above By 80 Percent			For 1" O.D. Tubes on 1¼" △ Pitch Multiply The Above By 75 Percent		

Note: For U-Tube and fixed tube sheet design the above listed approximate surface will fit in a shell 2 inches less in diameter than the size tabulated. (The above figures are for estimating unit size only).

The original exchanger (Example A) was a 26-inch diameter x 16-foot tube length with 1,200 square feet of tubular surface. Furnished with Admiralty tubes and NRB tube sheets the unit would have cost approximately $7,600.00. When the pressure drop was increased to 15 psi (Example C) the surface required became 1,010 square feet, the unit size was reduced to 24-inch diameter and the cost is now approximately $6,400.00.

Where extended surface is employed the improvement in the fouled tube side heat transfer rate is multiplied by the ratio of surfaces (that is, the total outside surface per foot over the inside surface per foot). The medium with the higher transfer rate is always on the inside of finned tubes hence the same degree of benefit is not found as shown in the previous case. The improvement on less surface required when the high rate only is effected is shown by Example G and H in Table 1.

There is a limit above which excessive velocity will cause erosion. In most cases, exchanger pressure drop is limiting and erosion is not a problem. A water cooled exchanger designed for 90°F. water probably will operate most of the year with water below 80°F. To control the operation or to conserve water, the quantity is reduced hence lowering the velocity below a danger point. If this item was originally designed with a higher allowable pressure drop and velocity, the resulting cutback would not be serious. Higher velocity will keep the unit clean longer, reduce the rate of fouling and fall out.

An economic evaluation will show in many cases that the reduced exchanger cost will more than offset any increase in pump cost. Improved operation and maintenance will offset increase in horsepower requirement. At a time when capital investment is the prime consideration of any new plant we cannot afford to overlook pressure drop in the heat exchangers.

ACKNOWLEDGEMENT

Appreciation is extended to M. A. Reichlen for assistance.

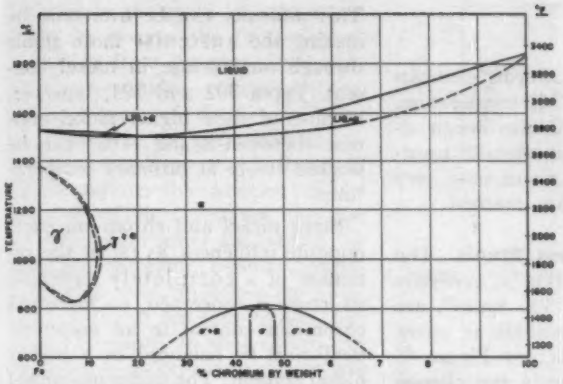


FIGURE 1—The iron-chromium equilibrium diagram. The dashed lines indicate some uncertainty as to their exact location.

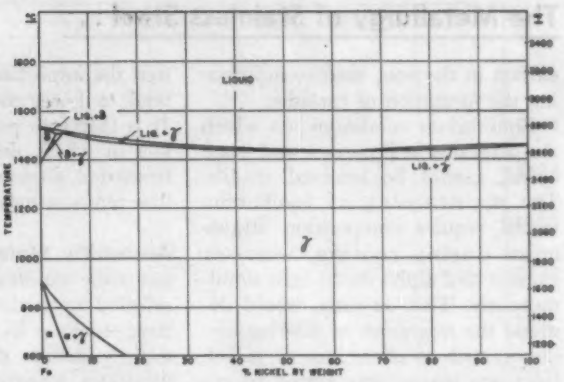


FIGURE 2—The iron-nickel equilibrium diagram shows that nickel addition to steel has the exact opposite effect as chromium addition.

Take a look at . . .

The Metallurgy of Stainless Steel

An up-to-date review of what happens inside stainless steel when various alloying elements are added and the effect on its properties

Franz R. Brotzen
The Rice Institute, Houston

THE TERM "stainless steel" is applied to a great many different iron-base alloys which have in common only the presence of large concentrations of chromium. It is the element chromium that, when present in concentrations of 12% or more, provide the alloy with its "passivity", i.e., its resistance to chemical attack. The great variety of commercially available types of stainless steels is an indication of the multitude of services to which this material is put and, consequently, of the many different service characteristics of mechanical, physical, and chemical nature that are expected of it.

How Iron-Base Alloys Change. In order to understand the metallurgical constitution of stainless steels, it might be well to review briefly the transformations occurring in pure iron and in low-alloy steels. When pure iron is cooled from the liquid state, it solidifies at 2802 F. (1539 C.) as body-centered cubic crystals referred to as delta iron. Upon further cooling, the iron undergoes an allotropic transformation from this body-centered cubic structure to a face-centered cubic structure at 2552 F. (1400 C.). This latter is generally called "gamma iron" and, when containing carbon in solid solution, constitutes the well-known austenite. At 1670 F. (910 C.) the iron returns to its original body-centered cubic crystal structure, alpha iron, which prevails even at the lowest temperatures. The latter type of iron, when containing small amounts of carbon in solution is called ferrite. The temperatures of these allotropic transformations, i.e., changes in crystal structure, in pure iron are represented by the intersections of lines with the left-hand temperature coordinate, the equilibrium diagram, in Figure 1.[1]

The temperatures of solidification and of allotropic changes are altered by the addition of soluble elements. As chromium is added to iron the delta-to-gamma transformation temperature tends to decrease. The gamma-to-alpha temperature decreases at first, but increase rapidly when more than 8% chromium is present. This tendency, illustrated in the diagram of Figure 1 by the loop on the left-hand side, limits the presence of the face-centered-cubic gamma phase to iron-chromium alloys containing a maximum of about 13% chromium.

Not all alloying elements tend to restrict the presence of the gamma form of iron. Figure 2,[1] for example, shows the iron-nickel diagram. It reveals the tendency of nickel to broaden the conditions under which the gamma phase prevails. Thus, the effect of nickel in this respect is exactly opposite to that of chromium. According to the diagram, in Figure 2 for example, body-centered-cubic alpha iron cannot exist in equilibrium at 800 F. (427 C.) when the nickel content exceeds 4 percent. The behavior of chromium and nickel in steels differs also in another respect. Chromium tends to form carbides by combining with the carbon generally present in the steel, while nickel favors the solution of

carbon in the iron, thereby suppressing the formation of carbides.

Equilibrium conditions, on which the diagrams in Figures 1 and 2 are based, cannot be attained readily. The maintaining of equilibrium would require composition adjustments during cooling, whenever gamma and alpha forms exist simultaneously. This, in turn, would demand the migration of alloying elements, such as chromium or nickel, from one microscopic region to another. Such a process of diffusion in the solid state is relatively slow even at high temperatures and comes to a virtual standstill at lower temperatures. Thus, when an iron-base alloy is rapidly cooled from a temperature in the gamma region to one in the region where alpha and gamma phases should coexist in equilibrium, it may happen that the alpha form will not have time to precipitate. The gamma form will then be retained by undercooling. If this is the case and if the reaction temperature has been lowered sufficiently, the alloy will suddenly change into a form closely akin to the body-centered alpha structure. This sudden transformation is not accompanied by diffusion and, therefore, the transformed regions do not undergo a change in composition. The well-known formation of mertensite in ordinary carbon steels takes place by such a process, leading to the hard microstructure which give steels their their heat treatability. The martensite structure is not an equilibrium structure and maintains the tendency to change eventually into the structure prescribed by the equilibrium diagram. It is significant that the temperature at which the transformation to martensite begins (M_s—temperature) is dependent primarily upon the composition of the alloy. One of the empirical relations between the M_s temperature and the composition in iron-base alloys is (2)

$$M_s\ (°F) = 925\ [\ (1 - 0.620\%\ C)\ (1 - 0.092\%\ Mn)\ (1 - 0.033\%\ Si)\ (1 - 0.45\%\ Ni)\ (1 - 0.070\%\ Cr)\ (1 - 0.029\%\ Mo)\ (1 - 0.018\%\ W)\ (1 + 0.120\%\ Co)\ ]$$

This simple formula, though generally applied to low and medium alloy steels only, indicates clearly that the important alloying elements tend to lower the M_s temperature. It is therefore possible to design alloys in which the martensite transformation does not occur until very low temperatures are reached.

Austenitic Stainless Steels. The austenitic stainless steels, generally referred to as the "300 Series", are designed so as to maintain an essentially austenitic structure. Figure 3[3] illustrates schematically the change in the maximum solubility of chromium in iron when nickel is added. While the gamma loop in a pure iron-chromium alloy extends to a maximum of nearly 13%, the addition of only 5% nickel pushes the gamma loop to a maximum of about 15% chromium. When an alloy containing 18% chromium and a few percent of nickel is cooled, some austenite will be retained. The ferrite structure fails to form altogether under ordinary circumstances if such an alloy contains about 7% nickel. The well-known "18-8" stainless steels, viz. 18% chromium and 8% nickel, are essentially austenitic, because a face-centered cubic crystal structure is retained even at relatively low temperatures.

When austenitic stainless steel is deformed at room temperature either in service or in fabrication, the tendency to revert to a hard structure of the martensite type is enhanced. This accounts for the severe work hardening observed in some austenitic steels and, to some extent, for the difficulty of their fabrication. Among the common austenitic stainless steels is, for example, type 301 containing about 17% chromium and between 6 and 8% nickel. Such a steel tends to work harden and therefore does not lend itself to cold fabrication. This difficulty can be overcome by making the austenite more stable through an increase in nickel content. Types 302 and 304, however, because of their higher nickel content (between 8 and 11%) can be worked freely at ordinary temperatures.

Since nickel and chromium exert opposite influences, as far as the retention of a completely austenitic structure is concerned, an increased chromium content in an austenitic steel must be balanced by a higher nickel content. The minimum nickel content to be maintained for the retention of the austenitic structure of given chromium content is illustrated in the diagram in Figure 4.[4] The validity of this rule becomes evident in the following commercial grades which combine higher chromium with higher nickel contents:

Type 308	20% Cr	10-12% Ni	0.08% C max.
Type 309	23% Cr	12-15% Ni	0.20% C max.
Type 310	25% Cr	19-22% Ni	0.25% C max.

Type 316, for example, contains 16-18% chromium, just like type 301. Yet, because of an addition of 2-3% molybdenum which, like chromium, tends to form ferrite, it becomes necessary to raise the amount of nickel (10-14%). Schaeffler[5] developed an impirical formula for the composition required to maintain a completely austenitic structure:

$$Ni + \frac{1}{2}Mn + 30\,C = \frac{Cr + 1.8\,M_o + 2.5\,Si + 2\,(Cb - 16)^2}{12} + 12$$

Amounts in this formula are given in weight percent.

The carbon content in austenitic steels is a matter of great concern. Carbon is present in austenitic stainless steel mainly because of production methods and is not added intentionally. The amount of carbon that can be dissolved in an austenitic stainless steel decreases rapidly at lower temperatures, Figure 5.[6] Below 1200 F. (650 C.), the solubility of carbon is very small, so that any carbon present will tend to precipitate in the form of carbides. Carbides are generally of a complex nature and have the chemical formula $(Fe, Cr)_xC$, in which the avid carbide-forming element chromium plays an important role. Carbide precipitation may lead to "sensitization", viz., an intercrystalline corrosion caused by the precipitation of

carbides in the grain boundaries. It seems to involve the formation of carbides from supersaturated austenite at suitable temperatures, whereby most of the precipitation takes place in the grain boundaries. In the immediate neighborhood of the boundaries the carbides rob the material of its chromium, so that low-chromium zones are formed. In these low-chromium regions the concentration may fall below the minimum required for stainlessness, i.e., 12% chromium, so that subsequent exposure to a corrosive medium will attack the network of depleted regions near the grain boundaries. This, in turn, will impair the mechanical properties of the material. Figure 6 illustrates the difference between grain boundaries virtually free of carbides and carbide precipitation in the grain boundaries of a mildly sensitized steel.

The tendency towards the undesirable carbide precipitation can be suppressed in two ways: either the carbon content is kept very low or the carbon is bound to another element in a manner such that the compound will be finely dispersed throughout the material instead of just being concentrated in the grain

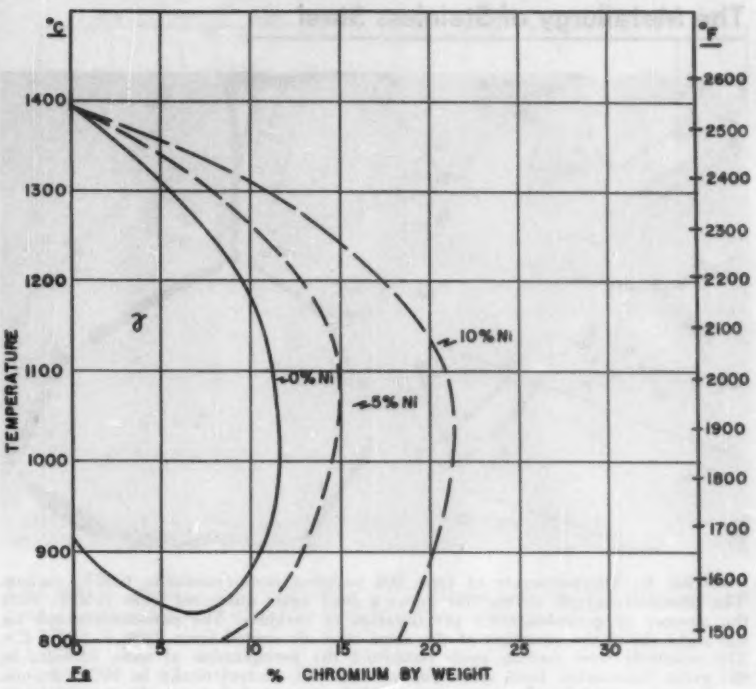


FIGURE 3—The solubility of chromium in iron is increased by adding nickel.

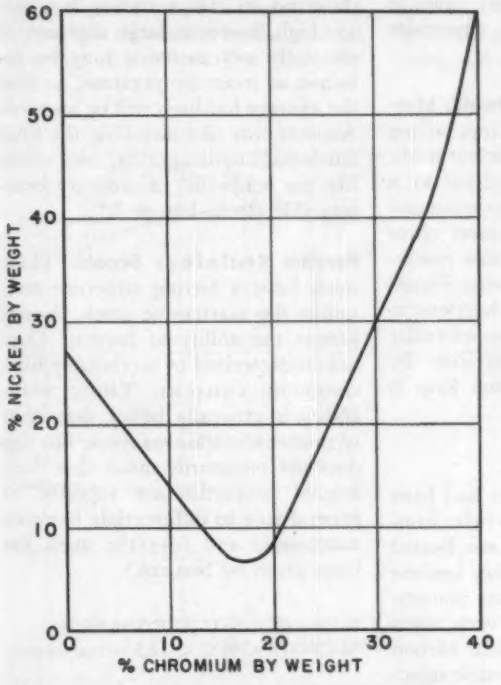


FIGURE 4—To keep an austenitic structure, a minimum nickel content must be added for each different concentration.

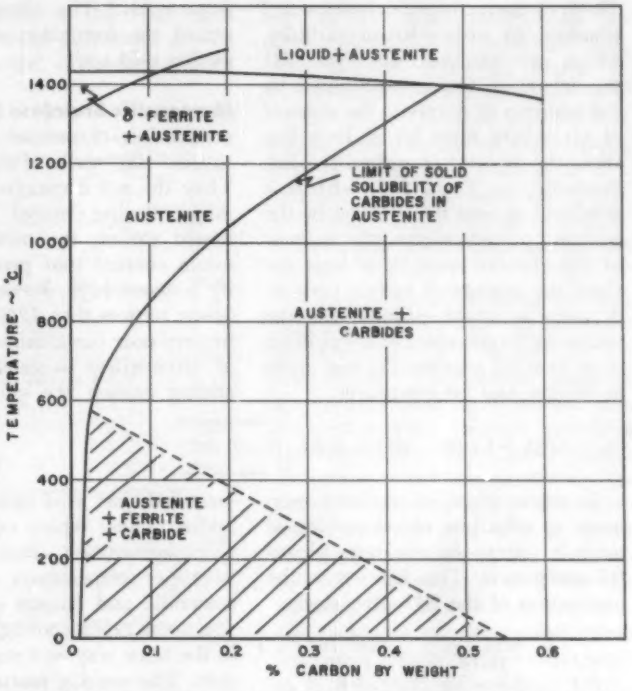

LIQUID + AUSTENITE
δ - FERRITE + AUSTENITE
AUSTENITE
LIMIT OF SOLID SOLUBILITY OF CARBIDES IN AUSTENITE
AUSTENITE + CARBIDES
AUSTENITE + FERRITE + CARBIDE
TEMPERATURE ~ °C
% CARBON BY WEIGHT

FIGURE 5—The amount of carbon that can be dissolved in 18-8 austenitic steel drops rapidly at lower temperatures.

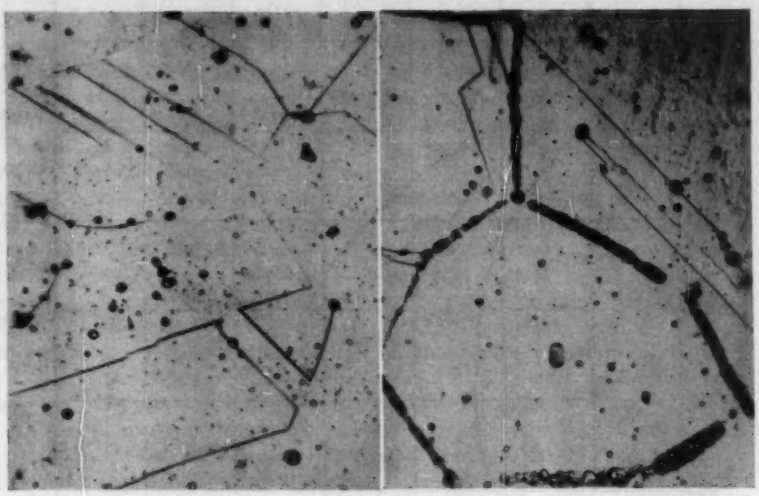


FIGURE 6—Microstructure of type 304 stainless steel containing 0.08% carbon. The photomicrograph on the left shows a steel water quenched from 1950 F. Note the absence of grain-boundary precipitation of carbides. The photomicrograph on the right shows the structure of the same steel air cooled from 1950 F (1066 C). The relatively slow cooling cycle permitted the precipitation of some carbides in the grain boundaries. Both specimens were etched electrolytically in 10% chromic acid solution intentionally for a long period so as to bring out the precipitation. Magnification: 500 X.

boundaries. The former is achieved in the so-called "Extra Low Carbon Steels," which generally contain no more than 0.03% carbon. The latter is done by the addition of either titanium or columbium (niobium). These elements form finely dispersed titanium or columbium carbides, which are harmless. In Type 321 stainless steel, which is stabilized by the addition of titanium, the amount of titanium must be at least five times the amount of carbon present. Similarly, in Type 347, which is stabilized against sensitization by the addition of columbium, the amount of this element must be at least ten times the amount of carbon present. A more accurate estimate for the minimum requirement of columbium so as to avoid sensitization was given by Binder and his coworkers:[7]

$$Cb = 0.093 + 7.7\,(C - 0.013) + 6.6\,(N - 0.022)$$

In recent years, efforts have been made to substitute nickel—which at times is scarce—by the more plentiful manganese. This has led to the production of the 200-series steels:

	AISI 201	AISI 202
Cr	16-18	17-19
Ni	3.5 — 5.5	4-6
Mn	5.5 — 7.5	7.5 — 10
C	0.15% max.	0.15% max.
N	0.25% max.	0.25% max.

Advantage is taken of the tendency of manganese, just like nickel, to enhance austenite formation. The corrosion resistance of the above two manganese steels is about the same as of ordinary types 301 and 302 respectively.[8] The nitrogen tends to retard the formation of martensite during cold work.

Martensitic Stainless Steels. Martensitic iron-chromium alloys belong to the "400" series of stainless steels. They do not contain nickel as a major alloying element. As was mentioned earlier, the minimum chromium content that provides passivity is about 12%. Reviewing Figure 1 one notices that 12% happens to be very near the maximum solubility of chromium in gamma iron. By adding carbon the gamma loop is extended, just as if nickel had been added. Thus, when certain iron-chromium-carbon alloys are heated to proper temperatures, they become austenitic and change into martensite upon rapid cooling, very much in the same way as a regular carbon steel. The ensuing martensitic structure still contains the original amount of chromium, so that stainlessness is maintained.[9] Should the steel be cooled very slowly it may happen that carbides precipitate, leaving behind a structure not only depleted in carbon but also in chromium and, therefore, vulnerable to chemical attack. Popular alloys of the martensitic series are No. 403 and 410, containing between 11.5 and 13.0% chromium and up to 0.15% carbon. Type 420 containing 12.0 to 14.0% chromium and between 0.30% and 0.40% carbon is generally used for cutlery, because the relatively high carbon content gives the required hardness. In order to dissolve carbides that may have formed earlier in the steel, the martensitic steels are generally heated to 1700-1800 F. (921-982 C.) prior to quenching. The high chromium content makes precipitation reactions somewhat sluggish so that most martensitic steels may be quenched from the austenitic temperature simply by cooling in air.

Since the heating temperature determines the amount of carbon dissolved in the austenite before cooling one could expect the hardness of the martensitic steel to rise with higher quench temperature. This, indeed, is the case. If the amount of carbon dissolved in the austenite becomes too high, however, large amounts of relatively soft austenite may be retained at room temperature, so that the average hardness will be lowered. Another way of controlling the final hardness is by tempering, very much like the tempering of ordinary heat-treatable steels, Figure 7.[4]

Ferritic Stainless Steels. These steels have a ferritic structure and, unlike the martensitic steels, do not possess the ability to harden. They are characterized by a relatively high chromium content. Their workability is generally better than that of martensitic stainless steels, but this does not necessarily mean that their impact properties are superior. A general rule to differentiate between martensitic and ferritic steels has been given by Samans,[6]

% Cr—17 × % C > 12.5 → ferritic.
% Cr—17 × % C < 12.5 → martensitic.

The increased chromium content tends to suppress the formation of

austenite so that martensite is also unable to form.

The phenomenon of intergranular corrosion is not restricted to austenitic stainless steels. Carbide or nitride precipitation associated with depletion of certain areas of chromium is possible also in ferritic steels.[10] When titanium is added so that the ratio of titanium: carbon is greater than 8 : 1, the precipitation is minimized. As a result, corrosion properties are improved. The cause for this behavior is not completely understood. The presence of austenite at high temperature is apparently not required to cause sensitization in ferritic steels. It is believed that the precipitation of a nitride or carbide in the grain boundaries stems from a ferrite which becomes supersaturated with nitrogen or carbon during cooling.

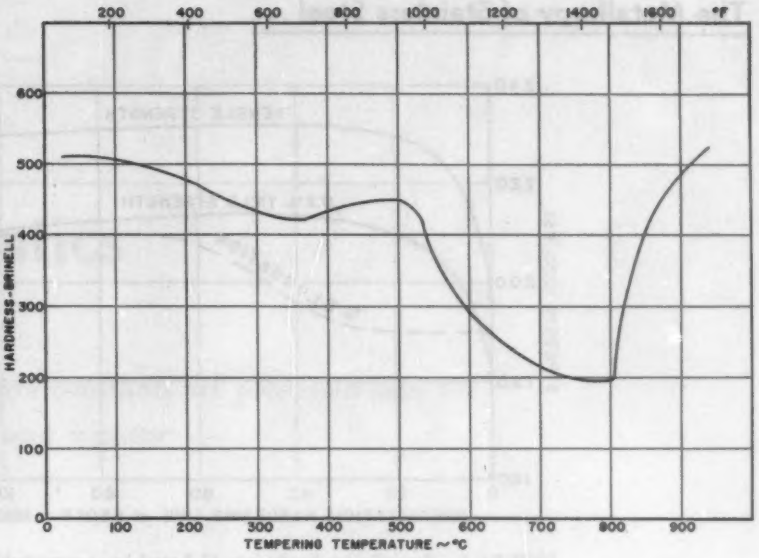


FIGURE 7—Stainless steel containing 0.3% carbon and 12-14% chromium will have a hardness as shown when tempered at various temperatures.

Formation of Sigma Phase. High-chromium alloys, such as stainless steels may form the so-called sigma phase. This phase tends to embrittle the material severely. In the iron-chromium equilibrium diagram, Figure 1, the equilibrium existence of this phase is indicated between the compositions of 23% and 67% and up to temperatures of about 1520 F. (827 C.). The greatest tendency towards sigma formation occurs in the very high chromium steels, such as those of the 300 series. Yet, the sigma phase is not limited to the austenitic steels. The boundary (Figure 1) indicating the lowest chromium content at which the sigma phase exists in equilibrium at different temperatures is shifted to lower chromium concentrations and to higher temperatures by the addition of silicon or manganese to ferritic steels.[11] Carbon, on the other hand, by binding some chromium in carbides, raises the chromium concentration at which sigma may become prevalent. The presence of carbides in the steel, however, will tend to accelerate the precipitation of the sigma phase.

In austenitic stainless steels the precipitation of sigma is hastened by the presence of ferrite particles. If both austenite and ferrite are present in a stainless steel, sigma will tend to form first in the ferritic portions because these are higher in chromium than the austenitic portions.[12] It is therefore possible that sigma may form in an alloy whose over-all chromium content is apparently too low to cause sigma precipitation, simply because the chromium tends to concentrate in the ferrite.

The rate at which sigma precipitates depends not only on the composition of the alloy but also on the temperature. The general form of the precipitation curve plotted as a time-temperature relation resembles the well-known "Time-Temperature-Transformation" diagrams or "S-curves" of decomposition of austenite in alloy steels. Figure 8, for example, demonstrates this relationship in a 310-type steel.[13] The interesting fact is that cold deformation tends to accelerate the sigma formation substantially, so that some of it may form in less than 3 minutes. Annealed steels, on the other hand, usually require long times for

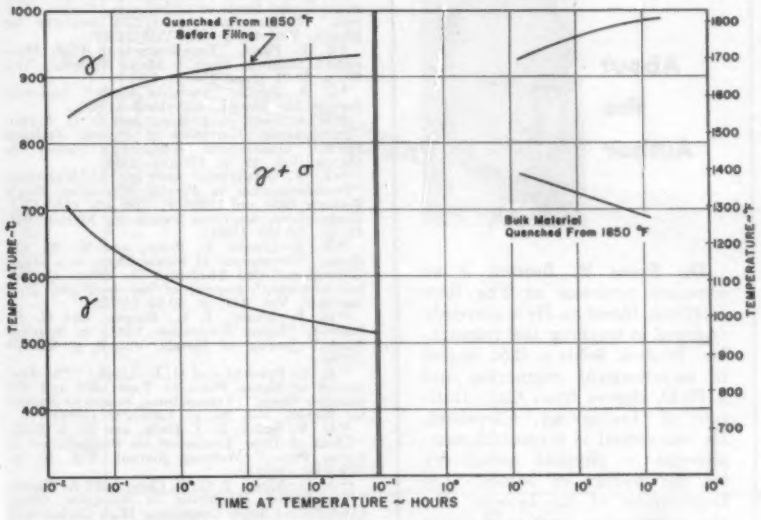


FIGURE 8—Sigma precipitation rate depends on temperature as well as alloy composition. S-curve diagram of type 310 (left) was obtained from heavily cold-worked material while the right diagram represents the material in the quenched condition.

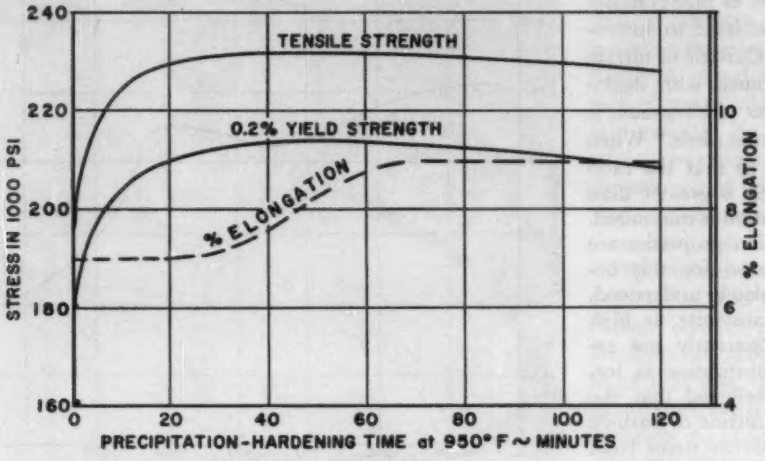


FIGURE 9—Precipitation-hardening, 17-7 steel has a remarkable increase in strength after heat treatment without excessive loss in ductility.

a noticeable formation of sigma. In the case shown in Figure 8, it would take about 100 hours at 1450 F. (788 C.) before any sigma phase becomes noticeable. Similarly, fine-grained steels will tend to precipitate the sigma phase more readily than coarse-grained ones.[14]

As for the amounts of sigma formed, they may be as high as 10% in an austenitic steel containing 25% chromium and 20% nickel when cooled from a temperature near 1700 F. (927 C.).[15] Yet, when the same steel is cooled continuously from a higher temperature, e. g. 1900 F. (1038 C.), sigma formation is virtually eliminated.

Precipitation-Hardening Stainless Steels. In recent years, precipitation-hardening stainless steels have gained considerable acceptance as heat-treatable, corrosion-resistant materials. A steel with the basic composition of 21% chromium, for example, can be hardened by the methods used in age hardening many non-ferrous alloys. The steel is quenched from a high temperature and, subsequently, aged at relatively low temperatures. The precipitate responsible for the increase in strength and hardness forms upon aging and, in this case, is thought to be a chromium carbide.[16]

Carbon, however, is not the only possible precipitating agent. In the 17-7 type precipitation-hardening steel, which contains 17% chromium, 7% nickel, only 0.07% carbon, and 1.2% aluminum, the precipitate is believed to be an intermetallic compound of aluminum and nickel.[17] This steel, in a characteristic heat treatment, is conditioned at 1750 F. (954 C.), air cooled, refrigerated at —100 F. (—73 C.), and allowed to precipitate at 950 F. (510 C.). The results of this heat treatment are shown in Figure 9. It clearly demonstrates the remarkable increase in strength without excessive loss of ductility.

About the Author

Dr. Franz R. Brotzen is an associate professor at The Rice Institute, Houston. He is currently engaged in teaching and research. Dr. Brotzen holds a B.S. degree in metallurgical enginering and a Ph.D. degree from Case Institute of Technology, Cleveland. He has served as a research metallurgist in physical metallurgy for the Bureau of Mines, U.S. Department of the Interior. He also spent some time as a senior research associate for Case Institute.

LITERATURE CITED

[1] M. Hansen, "Constitution of Binary Alloys," 2nd Ed., McGraw-Hill Book Co., Inc., New York (1958).
[2] L. A. Carapella, Discussion of an article by P. Payson and C. H. Savage, Transactions, American Society for Metals, Vol. 33, p. 277-279 (1944).
[3] Taken from a Data Sheet, Metal Progress, Vol. 62, p. 96B (Aug. 1952).
[4] J. H. G. Monypenny, "Stainless Iron and Steel," 3rd Ed., Chapman and Hall Ltd., London (1951).
[5] A. L. Schaeffler, "Selection of Austenitic Electrodes for Welding Dissimilar Metals," Welding Journal, Vol. 26, p. 601s-620s (1947).
[6] C. H. Samans, "Engineering Metals and Their Alloys," Macmillan Co., New York (1953).
[7] W. O. Binder, C. M. Brown, and R. Franks, "Resistance to Sensitization of Austenitic Chromium-Nickel Steels of 0.03% max. Carbon Content," Transactions, American Society for Metals, Vol. 41, p. 1301-1370 (1949).
[8] R. E. Paret, "Experience with High Manganese Stainless Steels," Metal Progress, Vol. 69, p. 68-71 (June 1956).
[9] C. A. Zapffe, "Stainless Steels," American Society for Metals, Cleveland (1949).
[10] R. A. Lula, A. J. Lena, and G. C. Kiefer, "Intergranular Corrosion of Ferritic Stainless Steels," Transactions, American Society for Metals, Vol. 46, p. 197-230 (1954).
[11] F. J. Shortsleeve and M. E. Nicholson, "Transformations in Ferritic Chromium Steels Between 1100 and 1500° F. (595 and 815° C)," Transactions, American Society for Metals, Vol. 43, p. 142-160 (1951).
[12] R. E. Lismer, L. Pryce, and K. W. Andrews, "Occurrence of Sigma Phase in a High-Chromium-Nickel Steel and the Effect of Carbon Content," Journal of the Iron and Steel Institute, Vol. 171, p. 49-58 (1952).
[13] G. F. Tisinai, J. K. Stanley, and C. H. Samans, "Sigma Nucleation Times in Stainless Steels," Journal of Metals, Vol. 8, p. 600-604 (1956).
[14] R. C. Frerichs and C. L. Clark, "The Formation of Sigma Phase in Types 309 and 310 Stainless Steels," Transactions, American Society for Metals, Vol. 46, p. 1285-1297 (1954).
[15] G. V. Smith, E. J. Dulis, and H. S. Link, "Effect of Prior Treatment on Precipitation of Sigma Phase," Welding Journal, Vol. 30, p. 385s-396s (1951).
[16] A. G. Allten, J. G. Y. Chow, and A. Simon, "Precipitation Hardening in Austenitic Chromium-Nickel Steels Containing High Carbon and Phosphorus," Transactions, American Society for Metals, Vol. 46, p. 948-972 (1954).
[17] M. W. Marshall, D. C. Perry, and N. R. Harpster, "Enhanced Properties in 17-7 PH Stainless," Metal Progress, Vol. 70, p. 94-98 (July 1956).

K's for Aromatics

Vaporization equilibrium constants are presented here for toluene, ethylbenzene and cumene

D. S. Hoffman and J. H. Weber
University of Nebraska, Lincoln

THIS ARTICLE presents vaporization equilibrium constants, K's, for toluene over the temperature range 60 to 460 F. and to a pressure of 350 psia and for ethylbenzene and cumene over the same temperature range and to a pressure of 300 psia. In order to design units for any separation process in the processing of aromatic hydrocarbons a knowledge of these vaporization constants is necessary.

In previous papers Hoffman and Weber[2,3] have shown equations and methods of calculating the equilibrium vaporization constants. The methods were discussed in considerable detail. The equations are shown here and the reader is referred to the earlier article for the nomenclature, methods and discussion.

$$K = \frac{f_l^\circ}{f_v^\circ} \qquad (1)$$

$$K' = K\frac{\gamma}{\phi} \qquad (2)$$

$$\ln Z = \frac{\beta - V_l}{RT}(\pi - P_v) \qquad (3)$$

$$f_l^\circ = f_{P_v}\left[\exp\frac{V_l}{RT}(\pi - P_v)\right] \qquad (4)$$

The basic assumptions used are that an equation of state which includes only the first virial coefficient

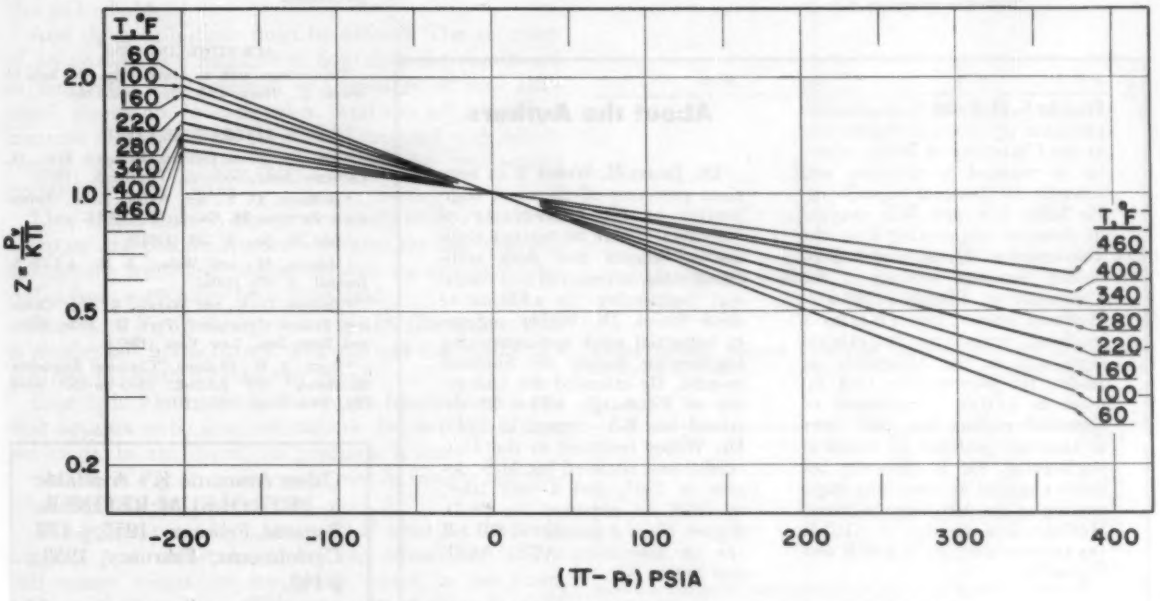


FIGURE 1—Plot of the logarithm of Z vs total pressure minus vapor pressure for toluene.

TABLE 1—Vaporization Equilibrium Constants for Toluene

Pressure, psia / Temp. F	14.7 (230.9)*	25 (264.9)	50 (316.1)	100 (377.8)	200 (452.7)	300 (503.7)	350 (524.6)
60	0.0238	0.0144	0.00785	0.00468	0.00339	0.00313	0.00309
100	0.0736	0.0425	0.0241	0.0139	0.0101	0.00902	0.00885
160	0.289	0.174	0.0934	0.0540	0.0365	0.0319	0.0309
220	0.843	0.519	0.269	0.152	0.0983	0.0834	0.0809
280	2.06	1.23	0.662	0.361	0.224	0.185	0.176
340	4.07	2.48	1.27	0.697	0.417	0.335	0.317
400	7.13	4.29	2.21	1.20	0.674	0.543	0.507
460	11.1	6.63	3.41	1.82	1.04	0.798	0.733

* Saturation temperature, F.

TABLE 2—Vaporization Equilibrium Constants for Ethylbenzene

Pressure, psia / Temp. F.	14.7 (276.7)*	25 (314.3)	50 (368.5)	100 (434.8)	200 (512.1)	300 (564.8)
60	0.00837	0.00510	0.00281	0.00173	0.00135	0.00125
100	0.0267	0.0160	0.00890	0.00539	0.00404	0.00374
160	0.122	0.0738	0.0401	0.0238	0.0168	0.0153
220	0.404	0.238	0.131	0.0772	0.0512	0.0450
280	1.04	0.627	0.336	0.189	0.122	0.105
340	2.32	1.38	0.732	0.411	0.254	0.211
400	4.26	2.65	1.33	0.732	0.441	0.355
460	7.24	4.32	2.25	1.22	0.715	0.559

* Saturation temperature, F.

TABLE 3—Vaporization Equilibrium Constants for Cumene

Pressure, psia / Temp. F.	14.7 (306.0)*	25 (345.5)	50 (403.9)	100 (474.9)	200 (558.6)	300 (615.5)
60	0.00387	0.00241	0.00135	0.000875	0.000717	0.000711
100	0.0137	0.00832	0.00470	0.00296	0.00233	0.00225
160	0.0693	0.0420	0.0234	0.0144	0.0108	0.00992
220	0.247	0.147	0.0819	0.0490	0.0353	0.0318
280	0.683	0.413	0.222	0.130	0.0887	0.0796
340	1.55	0.910	0.499	0.286	0.187	0.162
400	3.00	1.79	0.965	0.541	0.340	0.290
460	5.05	3.00	1.59	0.881	0.537	0.441

* Saturation temperature, F.

is valid, and the effect of pressure on the liquid volume is negligible.

To use the relationships above, the fugacities for the vapor state were evaluated from the generalized chart of Hougen and Watson.[5] The molal liquid volumes were obtained from API Research Project 44[1] and from the generalized correlations presented by Hobson and Weber.[4] Vapor pressure data were taken from API 44 and Perry's Handbook.[6] With this information it was then possible to evaluate the standard state liquid fugacity and, in turn, the vaporization equilibrium constant. To illustrate the nature of the log Z vs. $(\pi - P_v)$, this type of plot for toluene has been included as Figure 1. Similar plots were made for ethylbenzene and cumene. From the log Z vs. $(\pi - P_v)$ plots, ideal K values could be determined over a complete range of temperatures and pressures. The ideal K values obtained as a result of this work are reported in Tables 1, 2, and 3. In general the calculations were carried out up to values of the reduced pressure of 0.6. Above this reduced pressure the isotherm on log Z vs. $(\pi - P_v)$ plots have considerable curvature. Consequently, the calculations were limited to this value of the reduced pressure.

ACKNOWLEDGMENT

The authors wish to acknowledge the help of Wayne L. Horn with the calculations.

LITERATURE CITED

[1] Am. Petroleum Institute Research Proj. 44, Carnegie Inst. Technol., Pittsburgh (1953).

[2] Hoffman, D. S., and Weber, J. H., PETROLEUM REFINER, 34, No. 2, 137 (1955).

[3] Ibid.,37, No. 2, 143 (1958).

[4] Hobson, M., and Weber, J. H., A.I.Ch.E. Journal, 2, 354 (1956).

[5] Hougen, O. A., and Watson, K. M., "Chemical Process Principles" Part II, John Wiley and Sons, Inc., New York (1947).

[6] Perry, J. H., (Editor) "Chemical Engineers' Handbook" 3rd Edition, McGraw-Hill Book Co., New York (1950).

About the Authors

Dwight S. Hoffman is an associate professor of chemical engineering at the University of Idaho, where he is engaged in teaching and research in chemical engineering. He holds B.S. and M.S. degrees in chemical engineering from the University of Idaho, and has attended Summer sessions at the University of Illinois (1948-51). Hoffman started his career as a teaching assistant in general chemistry at the University of Idaho. He subsequently took up posts as assistant professor of chemical engineering, and later as associate professor of chemical engineering. He is currently actively engaged in consulting engineering in the petroleum industry. Hoffman is a member of AIChE (as an associate), ACS ASEE and Sigma Xi.

Dr. James H. Weber is an associate professor of chemical engineering at the University of Nebraska. There he teaches engineering classes and does additional work in research and chemical engineering. In addition to these duties, Dr. Weber engages in industrial work and consulting engineering during the Summer months. He attended the University of Pittsburgh, where he received his B.S. degree in 1941. Dr. Weber returned to the University and received his M.S. degree in 1947, and a year later, in 1948, he obtained his Ph.D. degree. He is a member of AIChE (as an associate), ACS, ASEE and Sigma Xi.

Other Aromatic K's Available in PETROLEUM REFINER.
Benzene, February, 1955, p 137
Cyclohexane, February, 1958, p 143

How Statistics Improve Lab Efficiency

Using these simplified statistical methods, quality of tests, samples and tester competence can be determined quickly

Maxey Brooke, Sweeny, Texas

AT ONE TIME or another every control laboratory supervisor has asked himself three questions:

1. How good are the tests we are using?

2. How representative are the samples we are testing?

3. How competent are the men who are doing the testing?

Statistics can answer these questions.

But don't statistics require a great deal of mathematics as well as a mass of calculations?

Not necessarily.

A number of short cuts have been developed to aid the busy man use the powerful tool of statistics.

Let's look at them.

How Good Are The Tests We Are Using? First we must define "good." A good test must be accurate, precise and reliable.

And these definitions must be defined. The accuracy of an analysis is a measure of how close the results are to the truth. The precision is a measure of how close check results are to each other. And the reliability is a measure of how today's results will compare with future results. Accuracy and precision can be represented graphically (See Figure 1).

Line 1, in Figure 1, represents results from a test both accurate and precise. Accurate because the results group around the truth and precise because the results do not differ from each other by a good deal.

Line 2, in Figure 1, represents results from a test that is precise but not accurate. The amount the results differ from the truth is called the "bias."

Line 3, in Figure 1, represents the results from a test that appears to be accurate because the average is near the truth. In any event, the precision is low.

Line 4, in Figure 1, represents results from a test that is neither accurate nor precise.

In any test procedure, the truth is what we are looking for. And unfortunately we can never find it. For this reason results are frequently shown in this form, 47.1 ± 0.12 percent. This means that there is a 95 percent (or 99 percent, if so specified) probability that the true value of the result lies between 46.98 percent and 47.22 percent. The smaller this ± value, the more precise is the test.

Column 2 of Table 1 gives the 10 percent points for

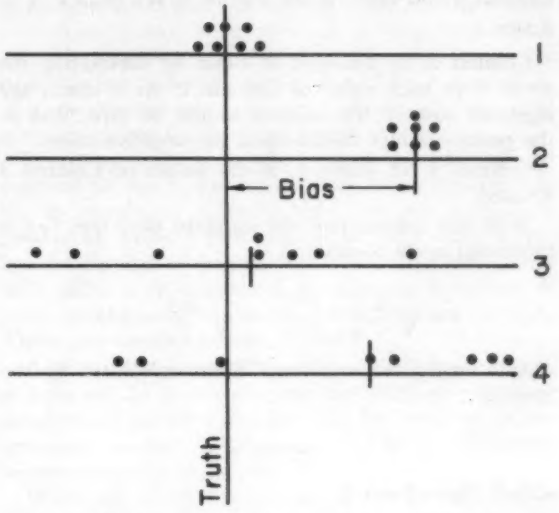


FIGURE 1—Is a graphical presentation of accuracy and precision for test results.

TABLE 1—Ten Percent Points of A.S.T.M. Gasoline Distillation

1 n	2 x	3 $x-\bar{x}$	4 $(x-\bar{x})^2$
1	129	−0.25	0.0625
2	128	−1.25	1.5625
3	130	+0.75	0.5625
4	129	−0.25	0.0625
5	124	−5.25	27.5625
6	131	+1.75	3.0625
7	132	+2.75	7.5625
8	131	+1.75	3.0625
	1034		43.500

$\bar{x} = 129.25$

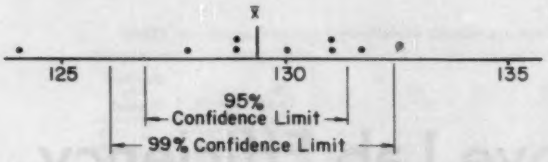


FIGURE 2—Shows the analysis range for two different confidence limits.

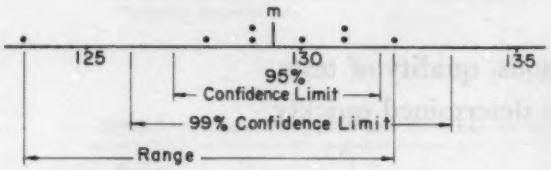


FIGURE 3—Confidence limits calculated by the short-cut method.

eight ASTM distillations of the same gasoline. First the classical method for finding the limits of this test will be shown; then a short-cut method will be given.

Classical Method—The average or mean value ($\bar{x}$) of the 10 percent points, found by adding the values in Column 2 and dividing the sum by 8, is 129.25 F. $\bar{x} = \Sigma x/n$

Column 3, in Table 1, is found by subtracting the mean from each value of Column 2. As a check, the algebraic sum of this column should be zero, that is, the positive values should equal the negative values.

Column 4, in Table 1, is the values of Column 3 squared.

With this information the standard deviation (σ) is calculated by the formula:

$$\sigma = \sqrt{\frac{\Sigma (x - \bar{x})^2}{n-1}} : \sqrt{\frac{43.5}{7}} = 2.49$$

And finally the confidence limits calculated by the formula:

$$l = t\sigma/\sqrt{n}$$

with "t" from Table 2.

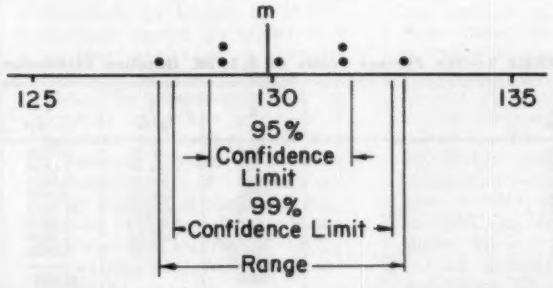


FIGURE 4—By rejecting the result farthest from the mean, the confidence limits are compressed.

For a 95 percent confidence limit, $2.4 \times 2.49 \div \sqrt{8} = 2.11$ and for a 99 percent confidence limit, $3.5 \times 2.49 \div \sqrt{8} = 3.08$.

This means that 95 times out of a 100, the 10 percent distillation point for this sample would fall in the range 129.25 ± 2.11, and that 99 times out of 100, the point would fall in the range 129.25 ± 3.08. These calculations are shown graphically in Figure 2.

Short-Cut Method. Without question, this is a lot of calculation for routine work. Fortunately it can be shortened. For example, instead of using the mean value ($\bar{x}$), the median value can be used. The median (m) is the value nearest the center. If an odd number of tests is used, the median is the center value. If an even number of tests is used, the median is the average of the two center values.

First, tabulate the tests in ascending or descending order:

124
128
129
129
130 > 129.5
131
131
132

The median is the average of the fourth and fifth value, 129 and 130 or 129.5.

The range (r) is the difference between the highest and the lowest value or $132 - 124 = 8$.

The confidence limits are found by multiplying the range by tw, taken from Table 2. For a 95 percent confidence limit, $8 \times 0.29 = 2.3$. For a 99 percent confidence limit, $8 \times 0.43 = 3.4$.

Thus 95 times out of 100, the 10 percent distillation point would fall in the range 129.5 ± 2.3 and 99 times out of 100, it would fall in the range 129.5 ± 3.4.

By inspection of Figure 3 it can be seen that one value is farther from the median than any other. Can it be omitted from the calculations? The "Q" test will tell. Find the difference between the questioned value and its nearest neighbor. In this case $128 - 124 = 4$. Divide this value by the range, $4 \div 8 = 0.5$, and compare it with the Q values in Table 2. If the value exceeds the tabulated value, it may be rejected with 90 percent certainty that it does not belong in the set.

With the seven tests now remaining, the range is 4, the median is 130, the 95 percent confidence limit is $4 \times 0.29 = 1.2$ and the 99 percent confidence limit is $4 \times 0.43 = 1.7$

How Representative Are the Samples Tested?

It is quite possible to set up a program wherein two or more samples are obtained and analyzed by different men. This is often not practical. However, many times, products are analyzed by your lab before shipment and by the receivers lab upon receipt. Just how representative the samples are can be determined by comparing these results.

Column 2 of Table 3 is a tabulation of the propylene content of a series of LPG samples by your lab. Column 3 is a tabulation of the analyses made by the purchaser. Column 4 is the difference between the two analyses. The algebraic sum of Column 3 divided by the number

of the samples (n) is the bias. In this case it is 0.7 percent. This simply means that because of differences in apparatus, techniques, and operators, your lab averages 0.7 percent higher than does the purchaser's lab.

Column 5 of Table 3 is the bias subtracted from the value in Column 4. Be sure and observe the signs.

The values in Column 5 of Table 3 are added, disregarding the signs, and the sum is divided by n — 1. This result, the average variation from sampling and measurement ($\bar{d}$), is 0.879.

Now tabulate the distribution of differences.

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.0	1	2	2	4	1	1	2	3	0	1
1.0	0	1	2	0	1	0	0	0	0	0
2.0	0	1	1	0	0	1	0	0	0	0

That is, one pair of results show no difference, two show a difference of 0.1, etc.

Table 4 shows the proportion of differences between duplicates which should exceed the indicated multiple of average differences ($\bar{d}$) between duplicates. That is, 69 percent of the differences between duplicates will exceed 0.5 times the average difference, 33.83 percent will exceed 1.2 times the average difference, or 4.61 percent of perfectly good results may be expected to show 2.5 times the average difference.

A comparison of the observed and expected differences will give a clue as to how representative are the samples tested.

TABLE 2—Confidence Factor Versus Rejection Quotient.[1]

Number of Observations	CONFIDENCE FACTOR				Rejection Quotient
	Student		Range		
n	$t_{0.95}$	$t_{0.99}$	$tw_{0.95}$	$tw_{0.99}$	$Q_{0.99}$
2	12.7	64.0	6.4	31.83	....
3	4.3	10.0	1.3	3.01	0.94
4	3.2	5.8	0.72	1.32	0.76
5	2.8	4.6	0.51	0.82	0.64
6	2.6	4.0	0.40	0.63	0.56
7	2.5	3.7	0.33	0.51	0.51
8	2.4	3.5	0.29	0.43	0.47
9	2.3	3.4	0.26	0.37	0.44
10	2.26	3.25	0.23	0.33	0.41
∞	1.96	2.576	0.00	0.00	0.00

TABLE 3—Propylene Content of LPG Samples

1 Test	2 Sellers Results	3 Buyers Results	4 Difference	5 Difference Corrected For Bias
1	54.1	54.3	—0.2	—0.9
2	57.3	57.3	0.0	—0.7
3	59.0	58.6	+0.4	—0.3
4	60.0	60.5	—0.5	—1.2
5	61.3	60.0	+1.3	+0.6
6	60.3	60.3	0.0	—0.7
7	61.9	60.6	+1.3	+0.6
8	63.4	64.1	—0.7	—1.4
9	61.9	61.2	+0.7	0.0
10	62.8	61.0	+1.8	+1.1
11	62.4	61.8	+0.6	—0.1
12	60.3	57.5	+2.8	+2.1
13	58.9	57.9	+1.0	+0.3
14	63.3	65.1	—1.8	—2.5
15	61.9	62.4	—0.5	—1.2
16	63.6	60.5	+3.1	+2.5
17	63.1	61.7	+1.4	+0.7
18	61.1	60.2	+0.9	+0.2
19	61.2	61.5	+0.3	—0.4
20	87.9	86.9	+1.0	+0.3
21	96.8	96.6	+0.2	—0.5
22	96.9	94.0	+2.9	+2.2
23	97.1	96.3	+0.8	+0.1
24	96.9	96.5	+0.4	—0.3
25	61.6	61.1	+0.5	—0.2
Σ			17.7	21.1
Bias			0.708	0.879
$\bar{d}$				

TABLE 4—Proportion of Differences Between Duplicates Which Exceed the Indicated Multiple of the Average Difference Between Duplicates.[2]

Multiple	0	0.2	0.4	0.5	0.6	0.8
0	1.0000	0.8733	0.7696	0.6900	0.6321	0.5233
1.0	0.4249	0.3383	0.2640	0.2314	0.2017	0.1509
2.0	0.1105	0.0792	0.0555	0.0461	0.0380	0.0255
3.0	0.0167	0.0107	0.0067	0.0053	0.0041	0.0024
4.0	0.0014	0.0008	0.0004	0.0003	0.0002	0.0001

TABLE 5—Comparison of the observed and expected differences in duplicate analysis.

Multiple of average diff.	Number of differences exceeding this multiple			
	OBSERVED		EXPECTED	
	Number	Percent	Number	Percent
0.5d 0.439	15	60	17.3	69.00
1.0d 0.879	9	36	10.6	42.49
1.5d 1.319	5	20	5.8	23.14
2.0d 1.758	4	16	2.8	11.05
2.5d 2.198	3	12	1.2	4.61
3.0d 2.637	0	0	0.4	1.67

The average difference between the observed and expected frequency in Table 5 is about 6 percent, which is quite good. If $\bar{d}$ exceeds 1.8 percent (2.0d), which means the absolute difference, corrected for 0.7 percent bias, exceeds 2.5 percent, retained samples should be checked.

How Competent Are the Testers? It is much simpler to evaluate a test method or a sampling procedure than to evaluate a man. If he knows he is being checked, his performance will tend to be better than his average. He is on his best behavior, so to speak. This is the fallacy of a co-operative test program. It shows only how good a technique can be, not how good it is.

However, there is a way around this, if you can evaluate his day to day work. One method involves taking the results of a stream that does not fluctuate a great deal. Table 6 gives the results for a week of carbon on catalyst as determined by four operators. Once each shift, a determination is made on a sample of spent catalyst and a sample of regenerated catalyst. These two samples constitute a pair.

A plot of the results (Figure 5) is made by laying off a scale on the x axis covering the range of the spent catalyst and on the y axis covering the range of the regenerated catalyst. Each pair of results can be represented as a point on the plot.

When all 29 points are plotted, a vertical line is drawn so that half of the points are left of the line and half are right of the line. A horizontal line is drawn so that half of the points are above and half below the line. The four quadrants thus obtained, share the points equally if only random errors were present in the analysis. Usually the points crowd the upper right and the lower left quadrants because of day to day variations in the carbon content as well as to the biases of the different operators.

These data are then treated as those in Table 3. The differences of the pairs are obtained, and these differences averaged to get the bias which is 0.625. The bias is subtracted from each difference, this column is added, ignoring the signs, and the sum is divided by n — 1 or 28. The results, $\bar{d}$, is multipled by $\sqrt{\pi/2}$ or 0.866 to

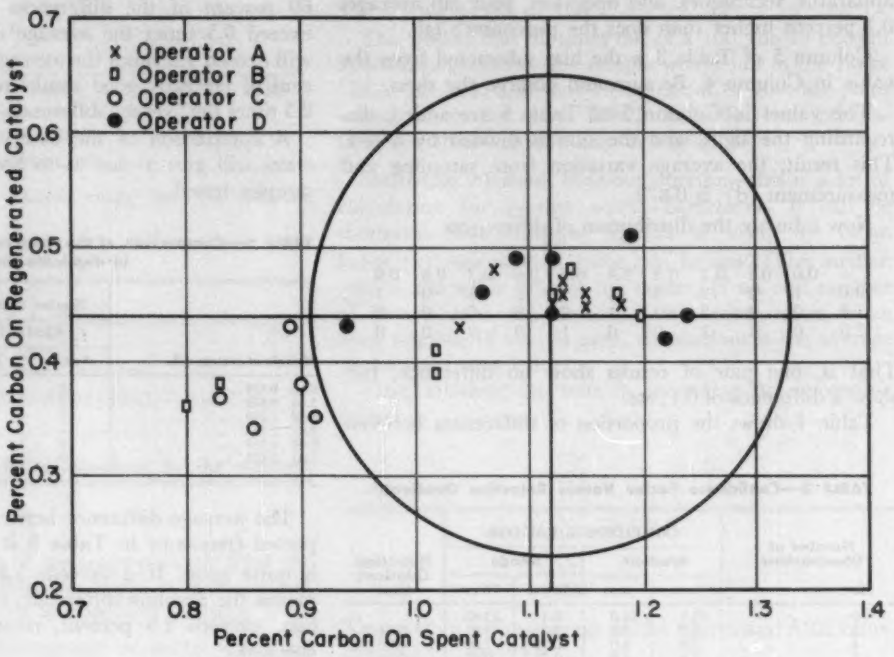


FIGURE 5—With no errors in individual operator technique, about 95 percent of the points should be in a circle whose radius is 2.45 times the standard deviation.

obtain the standard deviation of a single sample (SD), which is 0.076.

If there were no errors in individual techniques, about 95 percent of the points should lie in a circle whose radius is 2.45 times the standard deviation.

An examination of Figure 5 will reveal:

1. The results obtained by Operator A are both accurate and precise. This came as no surprise because he was recognized as being the best man in the lab.

2. Operator B has 6 points within the circle and 2 outside. This indicates that he does good work most of the time but is sometimes careless.

3. All of Operator C's points are outside the circle. Being in the lower left quadrant indicates that he is doing something which gives low results. An investigation showed that he was hurrying the absorption step in the test and not allowing the reaction to reach completion. Additional instruction corrected this error, indicating that he had not received proper training.

4. The results of Operator D came as a surprise. His rather flippant attitude had made his supervisor distrust his results. However this analysis showed that all his results fell inside the circle. In fact his results indicated that in precision and accuracy, he was second in ability only to Operator A.

The moral is obvious. Statistics can help the control lab supervisor.

Use them.

TABLE 6

Test	Carbon on Spent Cat.	Carbon on Reg. Cat.	Operator	Difference	Difference Corrected For Bias
1.....	0.83	0.37	C	0.46	—0.185
2.....	1.02	0.41	B	0.61	—0.015
3.....	1.02	0.39	B	0.63	0.005
4.....	1.13	0.46	A	0.67	0.045
5.....	1.15	0.45	A	0.70	0.075
6.....	0.90	0.38	C	0.52	—0.105
7.....	1.24	0.44	D	0.80	0.175
8.....	1.20	0.44	B	0.76	0.135
9.....	1.18	0.46	B	0.72	0.095
10.....	1.15	0.46	A	0.69	0.065
11.....	1.12	0.45	A	0.67	0.055
12.....	0.86	0.34	C	0.52	—0.105
13.....	1.09	0.49	D	0.60	—0.025
14.....	1.14	0.48	B	0.66	0.035
15.....	1.12	0.45	B	0.67	0.045
16.....	1.13	0.46	A	0.67	0.045
17.....	1.18	0.45	A	0.73	0.105
18.....	1.22	0.42	D	0.80	0.175
19.....	1.19	0.51	D	0.68	0.055
20.....	0.80	0.36	B	0.44	—0.185
21.....	0.83	0.38	B	0.45	—0.175
22.....	1.04	0.43	A	0.61	—0.015
23.....	1.07	0.48	A	0.59	—0.035
24.....	1.12	0.49	D	0.63	0.005
25.....	1.06	0.46	D	0.60	—0.025
26.....	0.91	0.35	C	0.56	—0.065
27.....	0.89	0.43	C	0.46	—0.185
28.....	0.94	0.43	D	0.51	—0.115
29.....	1.12	0.45	D	0.67	0.045
Bias $\bar{d}$				0.625	0.0856

LITERATURE CITED

[1] Dean, R. B., and Dixon, W. J., Analytical Chemistry 23, 536-8 (1951)
[2] Ind. Eng. Chem. 49, 79-80A, (April 1957)

About the Author

Maxey Brooke is a frequent contributor to PETROLEUM REFINER. With Phillips Petroleum Co. at its Sweeny, Texas, refinery, Brooke is a chemist with 22 years' experience, principally in water conditioning, waste disposal and corrosion control. His duties at Sweeny are as supervising chemist in charge of the refinery's analytical laboratory. Brooke has a B.S. degree from the University of Oklahoma.

New Way to Continuous H_2S Analyses

The amount of sulfur in a gaseous stream can be determined by measuring its absorption of low energy X-rays. Radiation is furnished by radioactive iron

Ernest R. Quiram
Esso Research and Engineering Company
Linden, N. J.

SINCE THE sulfur compounds in some refinery streams have commercial value, it is important to have a measure of their concentration. The quantity of low energy X-rays a sample will absorb is one way to determine the sulfur present. Radioactive Iron-55 offers a simple, convenient source of radiation; a Geiger-Mueller tube can be used to measure the energy absorbed.

The sulfur compound getting the most interest now is hydrogen sulfide. It is recovered from refinery streams to be converted into sulfur trioxide for sulfuric acid production. The instances where hydrogen sulfide is present in commercial quantities are growing because of the use of sourer crude oils and the more extensive use of hydrodesulfurization processes. Thus there is a growing need for a continuous sulfur monitoring system.

No plant experience has yet been obtained on the analyzer described here but results obtained on a laboratory scale indicate hydrogen sulfide in a concentration range from 0 to 100 percent can be measured with an absolute error of approximately ± 2 percent. The method is applicable to other sulfur bearing streams, providing associated components do not interfere. Likewise, Iron-55 has been used previously for the determination of sulfur in liquid hydrocarbons.[1]

The equipment used in this study consists of three main parts: (1) the radioactive source, (2) detecting instruments and (3) a sample cell.

The radioactive source was obtained from a commercially available sulfur determination apparatus. It consists of four millicuries of Iron 55 enclosed in a brass source holder. The source holder is fastened to a mounting plate which also holds the sample cell and a sliding mechanism for positioning the Geiger tube at various distances from the source.

The detector is a standard commercial Geiger tube. It is connected to either a suitable scaler and internal timer or to a precision ratemeter and recorder.

A simple gas cell constructed from stainless steel tubing was found to work quite satisfactorily. This cell was approximately 2 inches long and 1-inch in diameter and had windows of a polyester film sealed in at both ends. Small pieces of stainless steel (approximately 2 inch x ¼ inch) were threaded near each end of the gas cell and were used as an inlet and outlet for the flow of gas.

A laboratory test was made by preparing synthetic blends of hydrogen sulfide and air and analyzing them as shown schematically in Figure 1. The gases are fed through two calibrated rotameters into a mixing bottle containing glass beads. The mixed gases are then fed to the gas cell and vented to the atmosphere. By adjusting the flow of gases, blends of any desired concentration could be made.

The Geiger tube, scaler, and an internal timer were used as the detecting instruments in the laboratory evaluation of the method. The timer was accurate to 0.1 second and shut off the scaling circuit when a preset number of counts had been reached.

A linear relationship was obtained when the concentration of hydrogen sulfide was logarithmically plotted against count rate. Figure 2 indicates an increase in concentration from 0 to 100 decreased the count rate from 30,000 counts per minute to about 6,000 counts per minute.

Reasonably good recovery was achieved. Table 1 indicates that an absolute error of ± 2 percent can be expected at concentration levels ranging from 0 to 100 percent.

A new plant instrument was designed because of the favorable results obtained on the laboratory instrument. This unit consisted of the following:

- Iron-55 source
- Sample cell
- Geiger tube

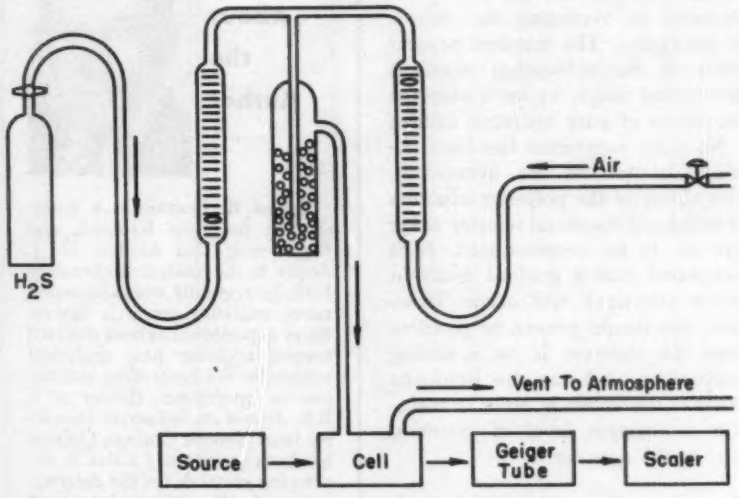


FIGURE 1—Synthetic blends of hydrogen sulfide and air were made to test the accuracy of the analyzer.

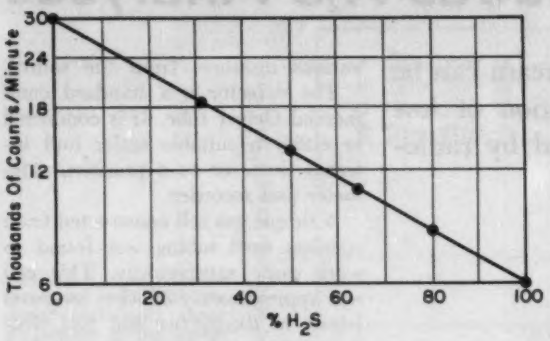


FIGURE 2—The hydrogen sulfide concentration is linear with the logarithm of the radiation counts per minute.

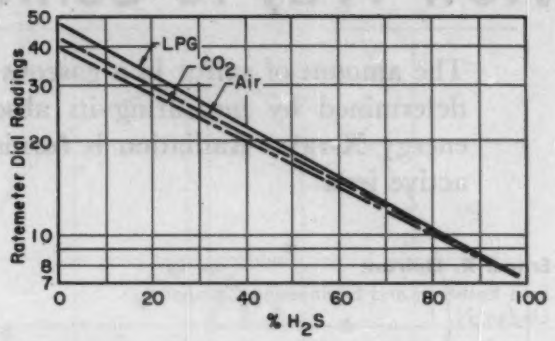


FIGURE 3—Associated gases affect the relation between sulfur and radiation. Therefore, a calibration curve is needed.

- Precision ratemeter
- Recording potentiometer

The precision ratemeter is particularly suitable for precision monitoring work. Its main advantage over the scaler is that it can be connected to a recorder and furnish a permanent record of the counting rate. The ratemeter used is capable of accepting counting rates up to 25,000 counts per minute. By means of a sliding mechanism, the Geiger tube can be placed in position at a convenient fixed distance from the source such that counting rates for all concentrations of H_2S from 0-100 percent will fall on the instrument scale.

Evaluation of the plant instrument was also performed in the laboratory. Results obtained from synthetic hydrogen sulfide-air blends are shown in Table 2, and these data indicate good agreement with the laboratory model instrument.

Gases absorb X-rays to a greater or lesser degree, depending upon the elements present in the gas. The larger the atomic number of the element, the greater the amount of absorption. When preparing calibration curves, therefore, the choice of base material becomes quite important. Figure 3 shows calibration curves when using carbon dioxide, LPG and air as the base materials. These curves were derived simply by measuring the absorptivities, expressed as dial readings of the instrument, and plotting these against concentration. An improper choice of base material can cause significant error at low hydrogen sulfide levels. For precise measurements, the most desirable way of preparing a calibration curve from an unknown gas is to pass the sample stream through acidified cadmium chloride to remove the hydrogen sulfide. The sulfide-free gas can then be fed to the sample cell and the zero point obtained by recording the degree of absorption. The hundred percent point of the calibration curve is determined simply by measuring the absorbtion of pure hydrogen sulfide.

TABLE 1—Determination Using Laboratory Instrument

% H_2S	
Added	Found
0	0
28	30
50	48
80	81
100	99

TABLE 2
Determination Using Plant Instrument

% H_2S	
Added	Found
0	0
16	18
38	38
50	50
62	64
84	87
100	100

No plant experience has been obtained as yet on the instrument. The ability of the polyester windows to withstand continual refinery usage has yet to be demonstrated. It is recognized that a gradual decay in source strength will occur. However, this should present no problem since the detector is on a sliding mechanism and can be brought closer to the source in order to maintain a constant level of counting rate in the detector.

The advantages gained from a continuous recording instrument of this type are numerous. It will give better and more reliable information that can be obtained through batch sampling techniques. The problem of sampling non-representative samples is eliminated. Essentially, no supervision on the part of the operator is required. Better control of plant operations can be maintained and the operator can immediately detect troubles when they occur at the plant. The cost of a continuous analyzer of this type is approximately $3,000-$4,000. This is not believed to be excessive when one considers the saving in skilled manpower that is obtained.

LITERATURE CITED

[1] Hughes, H. K., Wilczewski, Analytical Chemistry, 26, p 1889, (1954).

About the Author

Ernest R. Quiram is a senior chemist for Esso Research and Engineering Co., Linden, N. J. Active in the analytical chemistry field, he presently works in exploratory analytical research. His refinery experience has been directed toward applying new analytical techniques for controlling refinery process operations. Holder of a B.S. degree in industrial chemistry from Newark College, Quiram has been particularly active in developing methods for the determination of sulfur in petroleum, and the study of air pollution.

Heat Transfer Nomographs

Part 9—Water film coefficients for normal and annular flow

Part 10—Vapor condensation for saturated gases

Jose Alvarez C., Lubrisol de Mexico, S. De R. L.

Carlos Duhne, Instituto de Investigaciones Industriales
Monterrey, Mexico

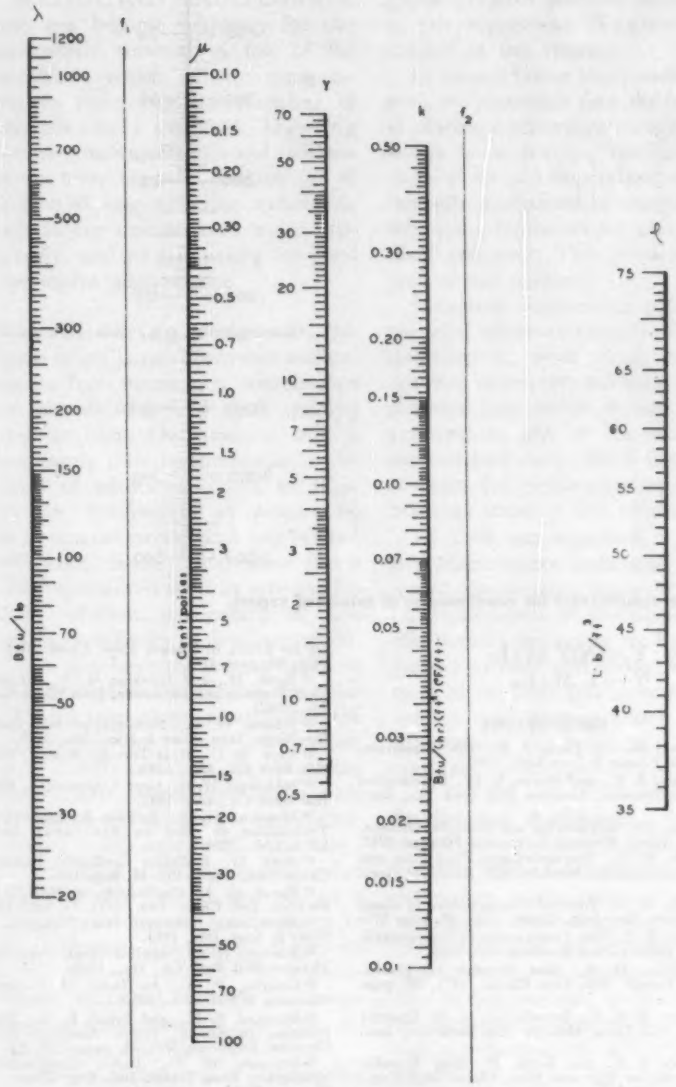


FIGURE 21—Factor Y for condensation of saturated vapors.

DESIGN OF CONDENSERS presents special problems in heat transfer calculations. These nomographs offer short-cut method of determining various factors in condenser equations. These time-savers can save many hours of computation time.

Vapor Condensation. Donohue,[7] Jacob and Hawkins[11] and McAdams[14] recommend the following equation for condensation of saturated vapors in film form, outside a row of N tubes one below the other:

$$h = 0.725 \left(\frac{k_f^3 \rho_f^2 g \lambda}{N D_o \mu_f \Delta t} \right)^{1/4}$$

And for vertical tubes, the following equation is recommended:

$$h = 1.13 \left(\frac{k_f^3 \rho_f^2 g \lambda}{L \mu_f \Delta t} \right)^{1/4}$$

Nomograph 21 was constructed to find the factor:

$$Y = \left[\frac{k_f^3 \rho_f^2 \lambda}{\mu_f} \right]^{1/4}$$

Where: λ, Latent heat of vaporization, Btu/lb.
ρ_f, Density of the liquid, lb./cu. ft.
μ_f, Viscosity of the liquid, lb./h. ft.
k_f, Thermal conductivity, Btu/hr. ft. F.

Example: Saturated steam at 212 F. condenses in horizontal tubes, with the surface temperature of 200 F. Find the factor Y if μ_f is 0.28 centipoises; ρ_f=60 lb./cu ft.; λ = 975 Btu/lb.; k_f=0.416 Btu/lb. ft. F.

The values for the properties of water correspond to a temperature of $\frac{212 + 200}{2}$ =206 F.

Solution: Using Nomograph 21 Y is found to be 21.

Nomograph 22 is used for the solution of the equations mentioned above, which can be put in the following form:

$$h_f = 0.725 \sqrt[4]{g \frac{Y}{N D' \Delta t}} \quad \text{and} \quad h_w = 1.31 \sqrt[4]{g \frac{Y}{L \Delta t}}$$

Where: h_f, Film coefficient, horizontal tubes
h_w, Film coefficient, vertical tubes
Y, Factor to be found through Nomograph No. 21
g, Acceleration of the earth, 4.17×10^{-8} ft./hr.²
N, Number of horizontal tubes, one below the other
D', External diameter, inches

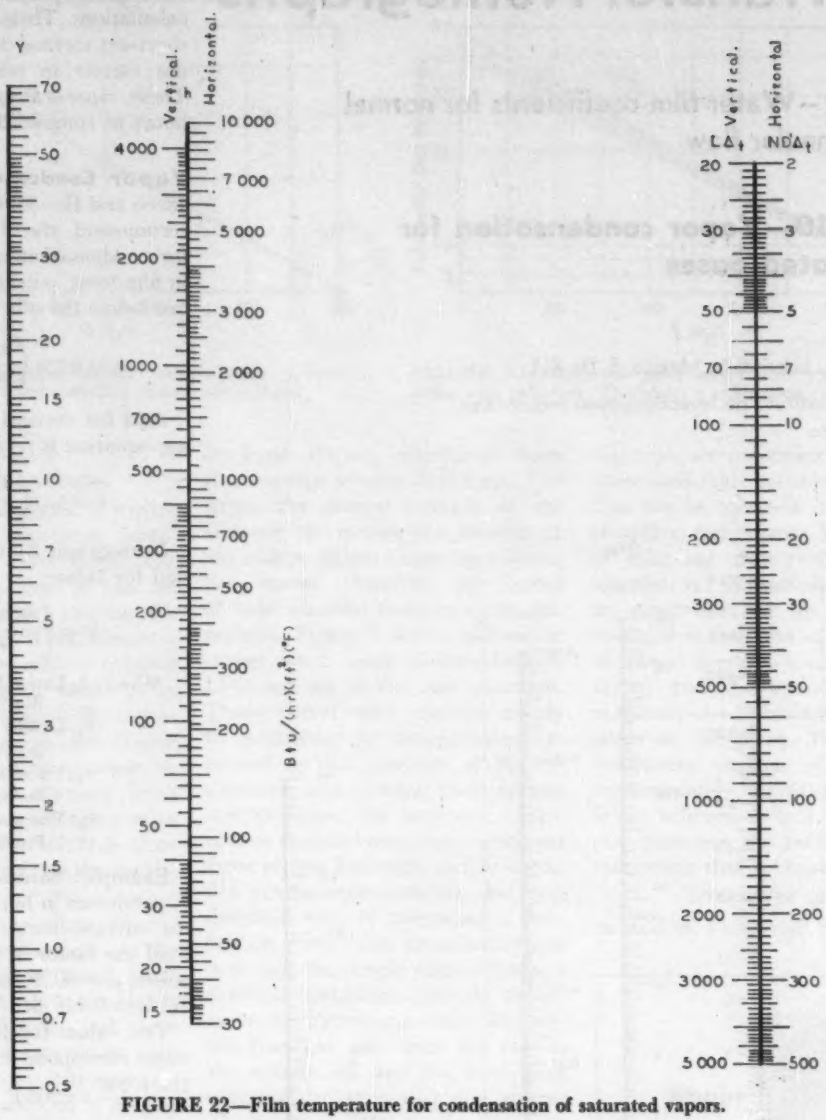


FIGURE 22—Film temperature for condensation of saturated vapors.

L, Length of the tubes, feet

Δt, Difference in temperature of condensing vapor and the surface of the tubes

Example: Vapor condenses at 212 F. in 16 horizontal tubes, placed one below the other. The external diameter of the tubes is 1 inch. The surface is 200 F.

Solution: Using Nomograph No. 21, the value of Y is found to be 21, $ND'\Delta t = 12 \times 1 \times 192$. Using Nomograph 22, a value of 1060 is found, for the film coefficient.

Some authors[14] recommend that the values obtained through the equation mentioned above, be multiplied by 1.1.

Key : $Y - ND'\Delta t : h_f$

$Y - L\Delta t : h_w$

BIBLIOGRAPHY

[1] Allock, R., and Jones, J. R., The Nomogram, Sir Isaac Pitman & Sons Ltd., 1946.

[2] Brown, A. L., and Marco, S. M., Introduction to Heat Transfer, McGraw Hill Book Co., Inc., 1942.

[3] Crane Co., Engineering and Research Division, Flow of Fluids Through Valves and Fittings, 1942.

[4] Croft, H. O., Thermodynamic Fluid Flow and Heat Transmission, McGraw Hill Book Co., Inc., 1938.

[6] Davis, D. S., Thermal Conductivities of Gases and Vapors, Ind. Eng. Chem., (41), 33, page 675.

[5] Davis, F. T., The Construction of Nomographic Charts, International Textbook Co., 1939.

[7] Donohue, D. A., Heat Transfer for Hydrocarbon Vapors, Ind. Eng. Chem., (47), 39, page 62.

[8] Eckert, E. R. C., Introduction to the Transfer of Heat and Mass, McGraw Hill Book Co., Inc., 1950.

[9] Hooks, J. I., and Kerze, F., Heat Transfer Coefficients for Pipe and Wire, Chem. Met. Eng., (45), 52, page 117.

[10] Hubard, D. O., and Roth, J. V., Heat Transfer for Fluids in Viscous Flow, Chem. Met. Eng., (42), 49, page 100.

[11] Jacob, M., and Hawkins, G. A., Elements of Heat Transfer and Insulation, John Wilway & Sons, Inc., 1942.

[13] Johson, H. L., Nomography and Empirical Equations, John Wiley & Sons, Inc., 1952.

[12] Kern, D. O., Heat Transfer Process, McGraw Hill Book Co., Inc., 1950.

[14] McAdams, W. H., Heat Transmission, McGraw Hill Book Co., Inc., 1942.

[15] Muraira, M. A., Estudio de Coeficientes de Transmision de calor en Secciones Anulares, I.T.E.S.M., 1954.

[16] Nord, M., Radiation Coefficient Nomograph, Chem. Met. Eng., (45), 44, page 117.

[17] Ryant, C. J., Coefficients on Heat Transfer Relation, Ind. Chem. Eng., (43), 35, page 1187.

[18] Shack, A., Industrial Heat Transfer, John Wiley & Sons, Inc., 1943.

[19] Stoever, H. J., Applied Heat Transmission, McGraw Hill Book Co., Inc., 1941.

[20] Douglas, P. A., An Index of Nomograms, Chaoman & Hall Ltd., 1950.

[21] Wiegand, J. H., and Baker, F. M., Transfer Processes in Annuli, Trans. American Institute Chemical Engineers, Vol. 38, pages 569, 592, 1942.

[22] Burrows, W. H., Direct Construction of Nomograms from Tables, Ind. Eng. Chem., (55), 47, page 33-37.

END OF SERIES

Take a look at how . . .

Atlantic Cuts Maintenance Costs

"A good preventive maintenance program which includes technical assistance to the maintenance force is the key to our cost reduction plan"

E. R. Schauffele and H. W. Parsons
The Atlantic Refining Company, Philadelphia

REDUCING MAINTENANCE cost has become necessary for our economic survival. A few of the methods which we are using include: reducing the number of maintenance employes, training maintenance mechanics and foremen to be more versatile, making use of industrial engineering techniques, scheduling maintenance more efficiently, and engineering for good preventive maintenance.

Consolidating Manpower. We have safely pared down our maintenance force through a combination of consolidated field craft training and attrition. Our training staff is constantly training mechanics in the skills of additional crafts to allow greater flexibility in performing maintenance work with increased efficiency. Some crafts must retain their specialized skills in order to remain efficient, particularly in view of the complexity of new equipment.

We also have trained our foremen to supervise many crafts to the point of being even more versatile than the mechanics. Our general job foremen now handle complete jobs involving most crafts. Specialized crafts such as instrument repairmen and electricians are still supervised separately.

The Esso plant at Bayonne, has adopted this method and reports a 20 percent over-all improvement in maintenance. Another plant reports a 37 percent reduction in maintenance manning through consolidation of manpower. Many other refineries are following suit.

The consolidation of crafts has stepped up our efficiency and is giving greater personal satisfaction to our supervisors. Teamwork is stressed in this system.

In consolidating manpower, however, we sometimes face the problem of placing a supervisor on a job with which he is not too familiar especially if he is a supervisor who has formerly specialized in one craft. In this case, the supervisor needs technical assistance. This poses the first part of our problem.

Industrial engineering techniques are used wherever possible. We have developed, since 1952, standard practice instruction manuals and engineered time studies. These manuals are used to give us the standard method and the standard time measurement for performing work. This helps us measure our efficiency.

In 1946, we organized a Preventive Maintenance committee consisting of maintenance supervisors from all departments of the plant. From this humble beginning we have progressed steadily and today, we have most of the principal aspects of preventive maintenance under control. Maintaining this program is the second part of the problem.

Technical Assistance. There is, therefore, a two-fold requirement to be met. That of maintaining a good preventive maintenance program and, at the same time, lending technical assistance to our shop, field, and operating supervisors. To take care of this problem, we have within the mechanical section (our maintenance organization) a development group.

The development group is composed of 17 men and a foreman trainee. The technical assistance rendered is extended to the mechanical section's maintenance forces as well as to our resident mechanics. The resident mechanics are permanently assigned to specific units or areas and are supervised by the operating groups. They perform routine maintenance work, while the major repairs and shutdowns are handled by the mechanical section.

The organization of the machinery engineering unit consists of 11 men and a trainee headed by the machinery engineer, who reports to the development group supervisor. Seven machinery technicians are delegated to separate areas of the plant, one of whom is assigned to the machine repair shop where he follows the work sent in for repair from the field. An associate machinery engineer makes special studies and keeps records of tests on materials, packing, seals, etc. He is re-

FIGURE 1—For very corrosive service, this epoxy pump piston costs one-tenth that of a carbon piston and lasts longer.

sponsible for applying the material specifications and shop procedures to our fabrication drawings. He also assists the technicians in the redesign of equipment or parts for special application or to meet some special need.

A junior machinery technician and a project technician take care of the development of drawings for the fabrication of parts. They also assist the machinery technicians when the workload so demands.

Files maintained in the machinery engineering office contain information in three basic categories: equipment data, maintenance records, and auxiliary files. The equipment data section includes:

- All assembly drawings, parts lists, erection and maintenance manuals, catalogs, and general correspondence from each manufacturer.
- Specification sheets for each item of machinery in the plant containing "nameplate" data, material specifications of wearing parts, the available sketch number for each part, ball or roller bearing numbers, coupling size, and packing and seal specifications. These sheets are kept in loose leaf books covering each operating unit. A copy of the appropriate book is kept in the control room of each unit and each machinery technician has copies pertaining to all units in his area.
- Copies of machinists bulletins which have been published and distributed to describe correct methods of performing difficult or unusual operations, convey pertinent information, or to warn against malpractices, are kept in sufficient quantities for redistribution, when required. Complete files of these bulletins are located throughout the plant.
- Tracings and prints for about 5,000 parts drawings, from which parts are fabricated in our shops.
- Identification sketches and location records of patterns.
- Interchangeability catalogs furnished to us by equipment manufacturers showing interchangeability of parts throughout their entire line.
- Catalogs of vendors of standard machine components, machinery accessories and basic materials, and of firms offering machinery repair services.

FIGURE 2—Eroded vanes on this pump impeller were built up with epoxy.

The maintenance records section of the files contains one folder for each machinery item in the plant. This folder contains:

1. Copy of original requisition.
2. Performance data.
3. Correspondence pertaining to individual machines.
4. Records of changes in location of service.
5. Technicians reports covering all major repairs.
6. Log sheet listing minor repairs.
7. Results of any subsequent performance tests made.

The auxiliary files consist of:

- Equipment locator file in which a card is devoted to each machinery location. On this card is listed the serial number, item number, manufacturer, size, and type of each machine at that location.
- Manufacturers file in which all machine of the same type, size, and manufacturer are listed on the same card.
- Date of last overhaul lists which are made up for each operating unit or machinery area. At 30-day intervals, copies are made on our blueprint machine and sent to the supervisers concerned and to the planning and scheduling group of the mechanical section for their use in planning shutdowns.

Our drawing file contains approximately 5,000 drawings of machinery parts. Most of these drawings duplicate the original part and some are modifications. These drawings are usually made from existing parts, but some are of parts designed as accessories to a machine or parts of a machine.

All fits, tolerances and surface finish specifications are standardized. Material specifications are based on documented maintenance experience and results of tests. Machining costs as well as durability of the various materials are also considered.

Drafting time has been cut in half by making pencil drawings on paper instead of ink on linen and adopting simplified drafting practices.

A drawing, when completed, must be checked by a technician and approved by the machinery engineer or the associate machinery engineer.

A coded numbering system indicating manufacturer, type, and size of the machine, and the name of the part, has been devised and drawings are filed by this number in the machinery engineering office.

Reference print files are located in all sections of the plant, but since their accurate maintenance cannot be assured, all prints in this category are stamped "FOR REFERENCE ONLY" so that they do not find their way into the shops as working drawings. All prints issued to the shops must come from the master file and be stamped "CERTIFIED FOR FABRICATION." They must be issued against the individual shop job number, marked with that job number, and initialed and dated by the member of the machinery engineering unit issuing the print. The shops are instructed not to work without a certified drawing or print assuring us that each part made in the shops is made according to the latest available information.

A small inexpensive blueprint machine is located in our office to make file copies and prints for "rush" jobs in the shop. Reference file copies and extra copies of our office files are made by the plant duplicating section.

These 5,000 drawings are constantly undergoing revision to take advantage of improved materials, interchangeability, reduction of costs through improved machining practices, and to meet changing service requirements. Approximately 600 new drawings are made each year.

Patterns. The machinery engineering unit completely controls the pat-

terns required for castings. A pattern number is issued by them and is shown on the drawing of the cast part. All machining allowances are specified and indicated on the drawing by dashed lines.

When the pattern is finished, a member of the machinery engineering unit checks it against the drawing. When the casting is received from the foundry it is checked again.

All patterns are checked periodically for condition and repaired as necessary. Patterns active within a five year period are kept in active storage areas and inactive patterns are kept in dead storage. Our records are examined annually so that obsolete patterns may be destroyed.

PREVENTIVE MAINTENANCE

A good preventive maintenance program is the backbone of the whole maintenance structure of any organization and it should begin with the first formulation of the idea of making a purchase of a piece of equipment. With this idea in mind, our development group takes an active part in the writing of standards which are used in preparing the specifications for the purchase of refinery equipment. We are thus able to point out desirable design features and avoid the purchase of equipment with which we have experienced maintenance difficulties.

Preventive maintenance requires the cooperation of both operators and mechanics. This cooperation must constantly be solicited and encouraged. The machinery technicians are in everyday contact with the operating personnel and mechanics in their respective areas to aid them in operating and repair problems, and to provide them with technical information. They also work together in setting up scheduled overhauls. One problem which the technicians are frequently called upon to resolve is that of determining the economies of immediate repair of a faulty piece of equipment as against allowing it to make a full run.

On many units, we have worked out, with our operating groups, a plan whereby most of the equipment may be overhauled or examined during the run rather than waiting for the scheduled shutdown of the unit. We can get to some of the equipment by using spare units or by taking it when it can safely be spared from operation. This saves time and manpower and allows the maintenance workload to be spread out more uniformly.

PM committee. The operation of our preventive maintenance committee has succeeded in making our preventive maintenance work cooperative and effective. We have come to enjoy a trustworthy reputation and our minutes are distributed to all areas of the company. It is through this committee that the machinery technicians are able to get their ideas evaluated and, if accepted, they are able to put them to practical use far more quickly than could be done otherwise. This allows us to take maximum advantage of all advances made in maintenance techniques and of the development of new materials.

The machinery technicians also cooperate with the operating and "resident" groups through separate meetings. Maintenance problems are discussed as well as the problem of having the proper number of spare parts on hand. Through these informal meetings, we are able to pool information effectively for the benefit of the entire plant.

Instruction Manuals. Standard practice instruction manuals, lubrication charts and machinery specification sheets containing all pertinent information for the proper maintenance of equipment are furnished to each operating center to maintain standardization of materials and repair methods. This material is reviewed at least annually to keep it pertinent.

Examination of equipment during the shutdown period is made by the machinery technicians and a check is made of the condition of all parts, including the alignment. This check-up includes a measurement of all clearances, examination for wear, corrosion, erosion, breakage and any unusual condition which would warrant further investigation.

Premature Equipment Failure. The investigation of individual maintenance problems has become one of the major functions of the machinery engineering unit. Occasionally a condition is found which may be common to a particular piece of equipment or peculiar to a certain service condition. At weekly meetings of the machinery engineering unit, problems of this type are discussed and a method of solution resolved. Equipment which fails before a scheduled overhaul receives particular attention. It is this type of unexpected failure which must be eliminated in order to reach a point of maximum efficiency in preventive maintenance.

FIGURE 3—This pump's warped cylinder heads caused leaks through the gasket. After coating the gasket surface with epoxy and the cover plate with parting grease, a perfect leak proof joint was cast in the field.

When maintenance records point up recurring machinery problems, a machinery technician is assigned to make an investigation to determine the cause of the problem. If it proves to be faulty lubrication, incorrect material or faulty repair methods, he suggests ways and means to make the correction. If it is inherent in the design, he redesigns the part if possible. If the design cannot be changed to remedy the situation, he recommends replacement of the equipment with something more suitable. In this case he must also write the justification for the replacement.

Inspecting too often. We have found that some equipment is better

FIGURE 4—Another leaking gasket surface was coated with epoxy and hand filed to restore flatness.

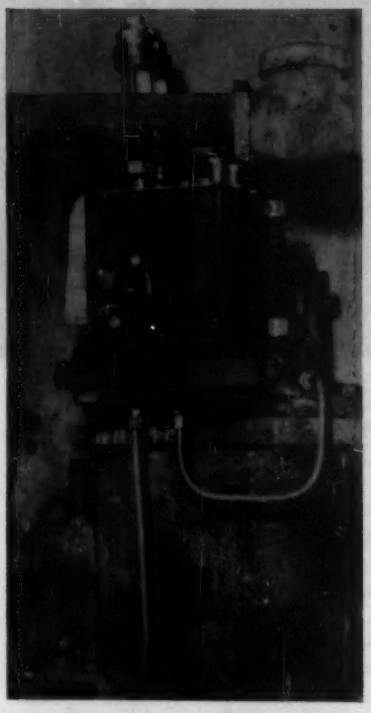


FIGURE 5—The Machinery Engineering group designed this lubricator which drastically cut maintenance costs on a locomotive type air compressor.

off left alone rather than to make too frequent inspections. In many instances it has paid to eliminate even an annual inspection and to allow the equipment to run as long as possible without opening it up. In order to determine an optimum period of operation and to keep the equipment running smoothly, we employ such devices as vibration analizers, dial indicators, stethoscopes, etc., to give us an indication of wear rates, trouble spots or other weaknesses which would warrant a more comprehensive physical examination.

Most of our repair methods are documented in our standard practice instruction manuals. Special jobs calling for new or different maintenance techniques are studied by the machinery technicians, after which they write up a procedure for the repair. The procedure then becomes a part of the historical record of the equipment and can be used for similar work in the future.

REPAIR METHODS

Repair methods are constantly being reviewed with regard to costs. Technical magazines, articles, books, papers, etc., are constantly being perused so that we may continue to keep abreast of new methods, tools and equipment as they are publicized. We have justified the purchase of chrome plating equipment for building up worn parts, vibration analyzing equipment, and a dry ice and solvent tank for use in making shrink fits. An anti-friction bearing conservation plan is now under way.

Cleaning and inspection methods are being reviewed and ultrasonic cleaning of bearings is being investigated. Many anti-friction bearings which would have been discarded are now being put back into service after careful cleaning and examination for defects. We believe that the number of bearings reclaimed will increase as the plan is perfected.

We perform many tests on new materials to evaluate their suitability for our needs. We are currently trying to determine the economics of chrome-plated vs. relined gas-engine power-cylinders.

Epoxy resins have been used to make repairs to cracked castings, leaking seams and worn or corroded machine surfaces, thus eliminating more costly repair methods. A pair of pump pistons cast from epoxy resin are now being used successfully in extremely corrosive service and have outlasted any material previously tested in this service (Figure 1). They were fabricated for $10 each while the carbon pistons previously used cost $108. A water pump impeller with eroded suction vanes was successfully built up with epoxy resin to restore the blading (Figure 2). A reciprocating pump with warped cylinder heads was successfully repaired by application of epoxy resin to the warped gasket surfaces (Figure 3). This saved the expense of disassembling the pump for removal to our shop for refacing. Another centrifugal pump with eroded gasket surfaces was returned to active duty by coating the surfaces with epoxy resin and hand filing them to restore the flatness (Figure 4). On all of these jobs a considerable amount of money was saved through the elimination of more conventional repair methods.

In order to solve some of our problems, special equipment must be designed. The maintenance costs were high for thirty locomotive type air compressors primarily because of erratic lubrication furnished by hydrostatic and capillary lubricators. The close-coupled design of these machines and the absence of external linkage afforded no drive for a mechanical lubricator (Figure 5). To solve this problem the machinery engineering unit designed a double-acting steam-powered driver which, when connected to both ends of the main steam cylinder of the compressor, oscillates in step with the compressor and furnishes power to operate a two-feed mechanical lubricator. Steam and air cylinders are now both fed the correct amount of lubricant and maintenance costs have been drastically reduced. ##

About the Authors

Schauffele Parsons

Edwin R. Schauffele is a supervisor in The Atlantic Refining Co.'s Development Group. As such, he is a technical consultant for the Maintenance Section, Philadelphia. He has a B.S. degree from Drexel Institute of Technology and is a member of ASM and NACE. Schauffele worked as a general job foreman and training coordinator, zone supervisor and development engineer before obtaining his present position. With Atlantic since 1930, most of his work has been in plant maintenance.

Horace W. Parsons is a machinery engineer for The Atlantic Refining Co. Philadelphia, where he supervises machinery engineering activities. Holder of a B.S. degree from Drexel Institute of Technology, he has previously worked as a machinery technician, machinist apprentice instructor and assistant machinery engineer, Parsons joined Atlantic in 1939.

Digital computer used to . . .

Figure Distillation This New Way

Part 1—New Covergence Method Will Handle Many Cases
Part 2—Product Purity Can Set Conditions for Column

W. N. Lyster
Humble Oil & Refining Company, Baytown, Texas

S. L. Sullivan, Jr., D. S. Billingsley and C. D. Holland
A & M College of Texas, College Station

A SUITABLE CONVERGENCE METHOD for use in conjunction with the Thiele and Geddes[18] approach to multicomponent distillations was presented in Part 1. The new convergence method is extended herein to include other types of specifications, such as product purity. Thus, instead of fixing the total quantity of distillate, one can specify now the mole fraction of any one of the components in the distillate.

This second part will be concerned with having the following column specifications given:

- Number of plates in each section
- Quantity, composition and thermal condition of the feed
- Column pressure
- Type of overhead condenser
- Reflux ratio or V_1 or L_0
- Product purity

All symbols and literature references were listed in Part 1, and the reader is referred to this earlier part for background material.

SPECIFY PRODUCT PURITY

A conventional column involves a single feed plate and the withdrawal of only distillate and bottoms products. To eliminate the necessity of solving for several distillate rates until a designed product purity is achieved, a procedure is proposed for solving explicitly for the product purity. The relations for various types of specifications are developed in the following sections:

1. Specifications: $\sum_{i=1}^{s} d_i$ or $\sum_{i=1}^{s} b_i$ where $1 \leqq s \leqq c$, and V_1 or L_0 or L_0/D.

When either the sum of the d_i's or b_i's and one of the flow rates, either V_1 or L_0, are specified, the system is fixed in the sense that no further specifications may be made. The first specification considered is $\sum_{i=1}^{s} d_i$, where none of the d_i's are known individually unless $s = 1$. Except as noted in "Specification 4," the components may be numbered in any arbitrary order. Part 1 shows the b_i/d_i's obtained by a given trial calculation can be related to a corrected set of values which are both in material balance and in agreement with the problem specifications. An emperical multiplier, Θ, is defined in Equation (1) of Part 1 and is repeated here for convenience as Equation (30).

$$\left(\frac{b_i}{d_i}\right)_{co} = \Theta\left(\frac{b_i}{d_i}\right)_{ca} \tag{30}$$

Thus, an expression for d_i is derived in Part 1 and is

$$(d_i)_{co} = \frac{FX_{Fi}}{1 + \Theta\,(b_i/d_i)_{ca}} \tag{31}$$

The desired value of Θ is the positive root which gives $g(\Theta) = 0$, where,

$$g(\Theta) = \sum_{i=1}^{s} \frac{FX_{Fi}}{1 + \Theta\,(b_i/d_i)_{ca}} - \sum_{i=1}^{s} d_i \tag{32}$$

It is to be noted that the second summation on the right hand side of Equation (32) is the specification. Equation (32) is readily solved for the desired value of Θ by any one of several methods (see for example Newton's method and interpolation, *regula falsi,* in the Reference).[18] Also, the application of Newton's method to an equation of the same form as Equation (32) has been discussed in detail in Part 1.

After the desired value of Θ has been calculated, the corrected value for each of the d_i's is obtained by use of Equation (31). Thus, the corrected distillate rate to be employed in the next trial calculation is obtained by summing both sides of Equation (31) from $i = 1$ through $i = c$, which gives

$$D_{co} = \sum_{i=1}^{c} \frac{FX_{Fi}}{1 + \Theta\,(b_i/d_i)_{ca}} \tag{33}$$

The corrected b_i's and the mole fractions of each component in the vapor and liquid streams leaving plate j are calculated in the same manner, as discussed in connection with Equations (9), (10) and (11) of Part 1.

When V_1 is taken as the second specification, the reflux rate is obtained by the material balance, $L_0 = V_1 - D_{co}$. Similarly, when L_0 is specified, V_1 is calculated by use of the same equation. When L_0/D is taken as the second specification, V_1 is calculated from $V_1 = (L_0/D + 1)\,D_{co}$.

The special case of the first specification where $s = c$ (the total distillate rate D is specified) has been discussed in detail in Part 1. It should also be mentioned that when the first specification is the $\sum_{i=1}^{s} b_i$, it may be

Figure Distillation This New Way . . .

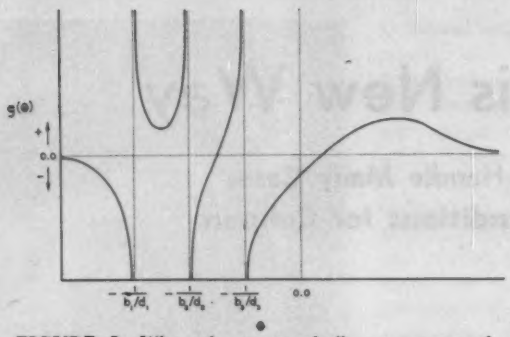


FIGURE 5—When the most volatile component of a three component system is specified, the equation for Θ has one negative and one positive answer.

restated, if desired, in terms of the d_i's, since $\sum_{i=1}^{s} d_i = \sum_{i=1}^{s} FX_{Fi} - \sum_{i=1}^{s} b_i$.

For this type of specification as well as "Specification 2" and "Specification 3" which follow, it is necessary that the specified sum of d's be less than the corresponding sum of FX_F's.

It should also be remarked that when the second specification is taken as V_1, solutions are possible provided a value of V_1 is specified such that the final corrected value for D will give a positive value for L_0, where $L_0 = V_1 - D_{co}$. The limiting value for D is F.

2. Specifications: d_1 or b_1 and V_1 or L_0 or L_0/D

This is actually a special case of 1, s = 1, where the components may be numbered in any arbitrary manner. The desired value of Θ may be calculated directly from Equation (32), which reduces to

$$d_1 = \frac{FX_{F1}}{1 + \Theta\,(b_1/d_1)_{ca}} \tag{34}$$

The corrected d_1's are calculated by use of Equation (31), while the total distillate rate to be employed for the next trial calculation is obtained by use of Equation (33).

3. Specifications: b_1/d_1 and V_1 or L_0 or L_0/D

This specification may be transformed to "Specification 2", since

$$d_1 = \frac{FX_{F1}}{1 + (b_1/d_1)}$$

4. Specifications: (a) A sum of X_D's and V_1 or L_0 or (b) A sum of X_B's and V_{N+1} or L_N

Although specifications consisting of other combinations of mole fractions and flow rates may be made, they are not treated herein.

Except where noted in the treatment of the above specifications, the components are numbered consecutively in the order of decreasing volatility, the most volatile being numbered one.

When a sum of X_D's and V_1 are specified, the first trial calculation is based on an assumed value for D, say F/2. The corrected value of D to be employed in the next trial calculation is calculated by Equation (33).

The value of Θ needed in Equation (33) is obtained by solving Equation (37) following for the positive root which gives $g(\Theta) = 0$.

When the sum of the first s values of X_D are specified, it follows that

$$D_{co} = D_{co} \sum_{i=1}^{s} X_{Di} + \sum_{i=s+1}^{c} \frac{FX_{Fi}}{1 + \Theta\,(b_i/d_i)_{ca}} \tag{35}$$

For convenience, let

$$a_D = \sum_{i=1}^{s} X_{Di}$$

Equation (35) may be rearranged to

$$D_{co} = \left(\frac{1}{1 - a_D}\right) \sum_{i=s+1}^{c} \frac{FX_{Fi}}{1 + \Theta\,(b_i/d_i)_{ca}} \tag{36}$$

Elimination of D_{co} between Equations (33) and (36) leads to the following expression.

$$g(\Theta) = \sum_{i=1}^{s} \frac{FX_{Fi}}{1 + \Theta\,(b_i/d_i)_{ca}} - \left(\frac{a_D}{1 - a_D}\right) \sum_{i=s+1}^{c} \frac{FX_{Fi}}{1 + \Theta\,(b_i/d_i)_{ca}} \tag{37}$$

When the specifications consist of the sum of the first s values of the X_B's and V_{N+1} or L_N, the following equations are derived and employed in a manner analogous to that given for Equations (31), (33) and (37).

$$(d_i/b_i)_{co} = \lambda\,(d_i/b_i)_{ca} \tag{38}$$

$$(b_i)_{co} = \frac{FX_{Fi}}{1 + \lambda\,(d_i/b_i)_{ca}} \tag{39}$$

$$B_{co} = \sum_{i=1}^{c} \frac{FX_{Fi}}{1 + \lambda\,(d_i/b_i)_{ca}} \tag{40}$$

$$g(\lambda) = \sum_{i=1}^{s} \frac{FX_{Fi}}{1 + \lambda\,(d_i/b_i)_{ca}} - \left(\frac{a_B}{1 - a_B}\right) \sum_{i=s+1}^{c} \frac{FX_{Fi}}{1 + \lambda\,(d_i b_i)_{ca}} \tag{41}$$

where,

$$a_B = \sum_{i=1}^{s} X_{Bi}$$

Examination of the Function g(Θ). Since most of the characteristics of a multicomponent mixture may be demonstrated by use of a three component example, it was selected for illustrative purposes. First, consider the case where X_{D1} (the mole fraction of the most volatile component) and V_1 are specified. Then

$$g(\Theta) = \frac{FX_{F1}}{1 + \Theta\,(b_1/d_1)_{ca}} - \left(\frac{X_{D1}}{1 - X_{D1}}\right) \sum_{i=2}^{3} \frac{FX_{Fi}}{1 + \Theta\,(b_i/d_i)_{ca}}$$

A graphical representation of this function is shown in Figure 5. It is seen to have one negative and one positive root. A necessary condition that the second root be positive rather than negative is that g(0) be less than zero. Since component "1" is the most volatile component, it

follows that $X_{D1} > X_{F1}$. Thus, when $\Theta = 0$, the above expression for $g(\Theta)$ reduces to

$$g(0) = \frac{F}{1 - X_{D1}}(X_{F1} - X_{D1}) < 0$$

Successive trials lead to the desired solution, provided the specified value of X_{D1} is less than that corresponding to the condition of total reflux in the rectifying section [$D = 0$, $B = F$, $V_j = L_{j-1}$ $(1 \leqq j \leqq f - 1)$, $\overline{V}_f = L_{f-1}$]. The largest possible value of X_{D1} is, of course, the one corresponding to total reflux in the rectifying section.

When the mole fraction, X_{D3}, of the least volatile component and V_1 are specified, it is found that $g(0) > 0$ and that the function has one, real, negative and one, real, positive root as illustrated by Figure 6.

Specification of X_{D2} and V_1 leads to the three possibilities shown in Figure 7. When $X_{F2} > X_{D2}$, it is readily shown that the function has one negative and one, real, positive root. When $X_{F2} < X_{D2}$, $g(\Theta)$ has either two, real, positive roots or two complex roots. The significance of these results is illustrated by Figure 8 in which a sketch of X_{D2} versus D over the entire range of operating conditions is shown. The distillate rates D_1 and D_2 correspond to those obtained by use of the larger and smaller positive roots, respectively. When the function $g(\Theta)$ has two complex roots, the lower curve in Figure 7 is obtained.

5. Specifications: (a) $\sum_{i=1}^{s} X_{Di}$, $1 \leqq s \leqq c-1$, and V_1 or L_0 or (b) $\sum_{i=1}^{s} X_{Bi}$, $1 \leqq s \leqq c-1$, and V_{N+1} or L_N

Investigation of the function $g(\Theta)$ for the first type of specification shows that a necessary condition for it to have a positive root is that $\sum_{i=1}^{s} X_{Di} > \sum_{i=1}^{s} X_{Fi}$. Similarly, for the second type of specification a necessary condition for the corresponding function to have a positive root is that $\sum_{i=1}^{s} X_{Bi} < \sum_{i=1}^{s} X_{Fi}$. After the desired root has been calculated by use of the appropriate form of the function $g(\Theta)$, the remainder of the calculational procedure is the same as that outlined in "Specification 1." The possibility exists of approaching a condition of total reflux in that section of the colum in which the specifications are made before obtaining the desired solution to a particular problem.

6. Specifications: (a) $\sum_{i=s'}^{c} X_{Di}$, $2 \leqq s \leqq c$, and V_1 or L_0 or (b) $\sum_{i=s}^{c} X_{Bi}$, $2 \leqq s \leqq c$, and V_{N+1} or L_N

It is readily shown that in order for $g(\Theta)$ corresponding to the first type of specification to have a positive root, a necessary condition is that $\sum_{i=s}^{c} X_{Di} < \sum_{i=s}^{c} X_{Fi}$. The corresponding condition for the second type of specification is that $\sum_{i=s}^{c} X_{Bi} > \sum_{i=s}^{c} X_{Fi}$. The calculational procedure is analogous to that outlined in "Specification 5." Again, the possibility exists of approaching a condition of total reflux.

7. Specifications :(1) $\sum_{i=s'}^{s} X_{Di}$, $2 \leqq s' \leqq s \leqq c-1$, and V_1 or L_0, or (2) $\sum_{i=s'}^{s} X_{Bi}$, $2 \leqq s' \leqq s \leqq c-1$, and V_{N+1} or L_N

When neither the most volatile nor the least volatile component is included in the specified sum of mole fractions, an examination of the corresponding function $g(\Theta)$ shows that for each type of specification, two possible solutions may exist.

Consideration of the first type of specification shows that when the specified soum of X_D's is less than the corresponding sum of X_{Fi}'s, the associated function $g(\Theta)$ has only one positive root as discussed previously for the three component example.

In the calculation of Θ, difficulty may be encountered in the use of Newton's method because the maximum value of the function in the vicinity of the origin, shown in Figure 7, may lie on either side of the origin. However, no difficulty is encountered when the method of interpolation (*regula falsi*), given in the Reference 14, is always applied between negative and positive values of the function.

When the specified sum of X_D's is greater than the corresponding sum X_F's, the possibility of either two positive roots or two complex roots exists. Also, for this specification as well as the above, there is the possibility of approaching total reflux in either section of the column. Although a direct method may be used when two possible solutions exist, it is recommended that several problems be solved where different values of Θ are specified at a given V_1, as described in Part 1 or by the procedure described in section 8 which follows. These methods are particularly recommended where all of the components between s' and s are not included in the specified sum because for specifications of this type, the possible shapes of the function $g(\Theta)$ become more numerous.

When the specified sum of X_B's is greater than the corresponding sum of X_F's, two possible solutions exist. The treatment of this case is the same as that described above.

8. Alternate Procedure for Specifications 4, 5, 6 or 7.

In addition to the specifications of sections 4, 5, 6 or 7; this procedure is readily applied to the special case where L_0 (orV_1) is fixed and the distillate rate is set at that one which gives the maximum purity, X_D, of a particular intermediate component (or components). Of course the distillate rate is unknown until a solution for the problem is obtained. Calculations are commenced

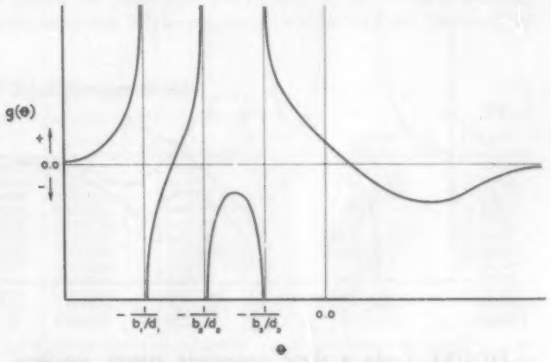


FIGURE 6—When the least volatile component of a three component system is specified, the equation for Θ looks like this.

on the basis of assumed values for all of the unknown quantities. After a set of $(b_i/d_i)_{ca}$'s for any given trial has been computed, an estimate of the mole fraction of any component or group of components as a function of Θ is readily obtained by calculating the values of $(d_i)_{co}$ and D_{co} by Equations (31) and (33), respectively, corresponding to each of several selected values of Θ. The range of values of Θ which may be employed depends primarily upon the range of the curve-fits of the data. Values of Θ from 0.001 to 1000 were successfully employed. For any component i and for each value of Θ, the mole fraction is given by $(d_i)_{co}/D_{co}$. As an application, consider again the three component example and suppose that the specifications are V_1 and the distillate rate corresponding to the maximum purity of component 2. A graph of the values of X_{D2} versus Θ gives a curve similar in form to that shown in Figure 7. Such a curve displays the particular Θ which gives the maximum purity of component 2. This value of Θ and the associated D are employed for the next trial. This procedure is repeated at the end of each trial until convergence is obtained; that is $\Theta = 1$ at the maximum purity. It is to be observed that an expression for the calculation of the Θ corresponding to the maximum purity is readily developed. Since $X_{D2} = (d_2)_{co}/D_{co}$ is a function of Θ alone, the desired expression is given by $dX_{D2}/d\Theta = 0$.

9. Specifications: (a) Temperature of Distillate and V_1 or L_0 or (b) Temperature of Bottoms and V_{N+1} or L_N

For illustrative purposes, it is supposed that the first specification is taken to be the dew point of the distillate at the column pressure. The expression for $g(\Theta)$ for this case is developed in the following manner. The corrected d_i's not only satisfy a material balance but also the dew point relationship,

$$1 = \frac{\sum_{i=1}^{c} (d_i)_{co}/K_i}{D_{co}} \qquad (42)$$

where the K_i's are evaluated at the specified temperature. Upon substitution of the relationships for $(d_i)_{co}$ and D_{co} as given by Equations (31) and (33), respectively, one obtains the equation $g(\Theta) = 0$, where

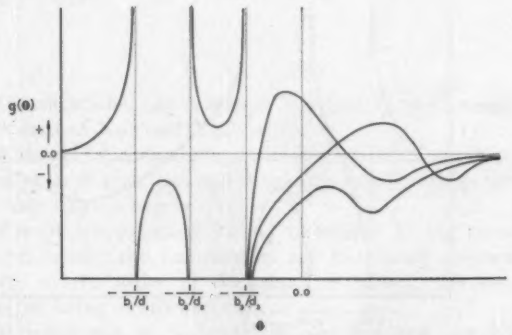


FIGURE 7—In a three component system, specification of the component having the intermediate volatility leads to three possible answers.

$$g(\Theta) = \sum_{i=1}^{c} \frac{FX_{Fi}\left(1 - \frac{1}{K_i}\right)}{1 + \Theta\,(b_i/d_i)_{ca}} \qquad (43)$$

After Θ has been calculated by use of Equation (43), the remainder of the calculational procedure is the same as that given in "Specification 1."

When the first specification is the temperature of the bubble point of the distillate, the following expression for $g(\Theta)$, developed in a manner analogous to that shown above, is applicable.

$$g(\Theta) = \sum_{i=1}^{c} \frac{FX_{Fi}\,(1 - K_i)}{1 + \Theta\,(b_i/d_i)_{ca}} \qquad (44)$$

In a manner similar to that illustrated previously, it is readily shown that the function defined by Equation (43) has c-2, real, negative roots and one, real, positive root, provided the specified temperature is greater than the boiling point of the most volatile component and less than the dew point of the feed at the column pressure. Similarly, when the temperature of the bubble point of the distillate is specified, the function defined by Equation (44) has c-2, real, negative roots and one, real, positive root, provided the specified temperature is less than the bubble point of the feed and greater than the boiling point of the most volatile component.

For each type of specification, successive trials lead to the solution for a particular problem, provided the specified temperature is not only within the above limits but also greater than that of the condenser at the condition of total reflux in the rectifying section. The upper temperature limit merely prohibits the making of a specification in which no rectification of the feed is to occur.

In order to obtain a solution when the temperature of the bubble point of the bottoms is specified, it is necessary that this temperature be greater than the bubble point of the feed and not only less than the boiling point of the least volatile component of the feed but also less than the temperature of the reboiler at the condition of total reflux in the stripping section.

TOTAL REFLUX IN ONE SECTION

The condition of total reflux in either section is a limiting condition which may be encountered in some of the above specifications. Because of this, a brief description of calculational procedures which may be employed when the rectifying section is operated at total reflux follows. For this case $D = 0$, $B = F$, $V_j = L_{j-1}$ $(1 \leqq j \leqq f\text{-}1)$, $\overline{V}_f = L_{f-1}$. The calculations (including heat, material and equilibrium balances) may be carried out in the stripping section by use of the Thiele and Geddes approach, as described in Part 1. In this approach, a set of calculations are terminated after v_{f1}/b_1 has been calculated. Since $b_1 = FX_{F1}$, corrected temperature profiles are calculated as described in Part 1 by taking $(b_i)_{co} = FX_{Fi}$.

After the v_{fi}'s have been obtained by use of the stripping section equations, stepwise calculations, consisting of material balances and equilibrium relationships, are continued in a direct manner to the condenser. The procedure is commenced as follows. Since v_{f1} and v_{F1} are known, the rate at which component i enters plate f-1 is given by $\overline{v}_{if} = v_{f1} + v_{F1}$. Since material balances require that $\overline{v}_{f1} = l_{f-1,1}$ and $\overline{V}_f = L_{f-1}$, one may calculate the $x_{f-1,i}$'s. Determination of the bubble

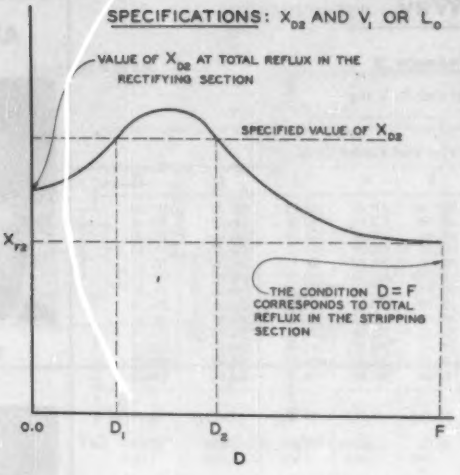


FIGURE 8—Here is a representation of concentration for one of the components over the entire range of operating conditions.

point temperature corresponding to these mole fractions gives the $y_{t-1,1}$'s. Then by the material balance $y_{t-1,1} = y_{t-2,1}$, the next set of liquid compositions are obtained.

Continuation of this procedure leads to the desired solution for the rectifying section. The procedure for both sections is repeated until the desired agreement between calculated values for successive trials is obtained. An analogous procedure may be stated for the condition of total reflux in the stripping section.

CALCULATING AND FORCING PROCEDURES

Refer to Part 1 for a detailed discussion of the general calculating procedure and the recommended forcing procedures.

ILLUSTRATIVE EXAMPLES

In order to demonstrate the use of each of the three different types of specifications, certain of the final results from the solution of Example 1, given in Table 10, were taken as the specifications for Examples 2, 3, 4. Actually, Example 1 is the special case s = c, listed previously as "Specification 1." This special case has been treated in detail in Part 1. Equilibrium and enthalpy data used in the solutions of the examples shown herein are given in Table 11. The results shown in Table 10 were obtained at the end of the tenth trial for which a D of 31.6006 was calculated. The corrected values for the d's and X_D's are shown while the calculated values for the temperature and vapor rates are listed. The results shown here differ from those obtained in Part 1 because of the difference in the specified values for the column pressure.

TABLE 10—Example 1

Comp.	FX_F	d	X_D
CH_4	2.0	2.0000000	$0.63291139 \times 10^{-1}$
C_2H_6	10.0	9.9998840	0.31645203
C_3H_8	6.0	5.9723350	0.18899794
C_3H_8	12.5	1.2346425×10	0.39070965
i-C_4	3.5	0.74224406	$0.23488737 \times 10^{-1}$
n-C_4	15.0	0.53708685	$0.16996419 \times 10^{-1}$
C_5	15.2	$0.20156709 \times 10^{-3}$	$0.63787054 \times 10^{-4}$
C_6	11.3	$0.94046890 \times 10^{-5}$	$0.29761674 \times 10^{-6}$
C_7	9.0	$0.63452667 \times 10^{-7}$	$0.20079958 \times 10^{-8}$
C_8	8.5	$0.44407697 \times 10^{-9}$	$0.14053069 \times 10^{-10}$
400	7.0	$0.65180963 \times 10^{-12}$	$0.20626887 \times 10^{-13}$
	100.0	31.600000	1.0000000

Plate Number	Temp. F.	Vapor Rate
0 (Distillate)	107.57	....
1	134.37	94.8
2	151.94	93.3
3	170.27	89.4
4 (Feed)	207.43	80.1
5	228.71	110.8
6	243.29	126.3
7	254.14	136.9
8	262.91	144.4
9	271.71	148.9
10	284.15	149.5
11	308.00	143.7
12 (Reboiler)	366.58	123.5

Specifications: D = 31.6, V_1 = 94.8, boiling point liquid feed partial condenser, column pressure = 300 psia, three rectifying plates, and eight stripping plates plus a reboiler.

The statement of Example 2 is the same as Example 1, except that the sum of the first three d's shown in Table 10 was specified instead of the total distillate rate, D. The solution of Example 2 is shown in Table 12. As described in Part 1, each of the temperature profiles after the first one shown in Table 12 was averaged (prior to making the next trial calculation) with the profile used to make the particular trial calculation. The final calculated values for the temperature profile, specification and total distillate rate are seen to be in good agreement with those shown for Example 1. It should also be mentioned that in the case of specifications of the types treated herein, it is necessary to assume some value for D in order to make the first trial calculation. The precise value employed did not appear to be of importance. In Example 2, D was taken equal to the sum of the three d's which was specified, while in Examples 3 and 4 a value of F/2 was used.

Example 3 differs from Example 1 in that the sum of the first three X_D's shown in Table 10 was specified instead of the total distillate rate. Some of the final results of the solution of this example are shown in Table 13. In order to illustrate the effect of the second forcing procedure the distillate rates calculated at the end of

TABLE 11—Enthalpy and Equilibrium Data*

Comp.	$a_1 \times 10^2$	$a_2 \times 10^6$	$a_3 \times 10^9$	$a_4 \times 10^{12}$	c_1	$c_2 \times 10$	$c_3 \times 10^5$	e_1	$e_2 \times 10^4$	$e_3 \times 10^8$
CH_4	32.718139	— 9.6951405	6.9229334	— 47.361298	— 17.899210	1.7395763	— 3.7596114	44.445874	501.04550	7.3207219
C_2H_6	— 9.8400210	67.545943	— 37.459290	— 9.0732459	— 8.4857000	1.6286636	— 1.9498601	61.334520	588.75430	11.948654
C_3H_8	—25.098770	102.39287	— 75.221710	153.84709	— 12.427900	1.8834652	— 2.4839140	71.828480	658.55130	11.299585
C_3H_8	—14.512474	53.638924	— 5.3051604	—173.58320	— 14.500060	1.9802223	— 2.9048837	81.795910	389.81910	36.470900
i-C_4	—18.967651	61.239667	— 17.891649	— 90.855512	— 16.553450	2.1618650	— 3.1476209	147.65414	—1185.2942	182.87778
n-C_4	—14.181715	36.866353	16.521412	—248.23843	— 30.298110	2.3005743	— 3.8663417	152.66798	—1153.4842	146.64125
i-C_5	— 7.5488400	3.2623631	58.507340	—414.92323	— 23.356460	2.5017453	— 4.3917897	130.96679	— 197.98604	82.549947
n-C_5	— 7.5435390	2.0584231	59.138344	—413.12409	— 24.371540	2.5636200	— 4.6499694	128.90152	— 2.0509603	64.501496
C_6	1.1506919	— 33.885839	97.795401	—542.35941	— 23.870410	2.6768089	— 4.4197793	85.834050	1522.3917	— 34.018595
C_7	5.5692758	— 50.705967	112.17338	—574.89350	— 25.314530	2.8246389	— 4.5418718	94.682620	1479.5387	— 19.105299
C_8	7.1714400	— 52.608530	103.72034	—496.46551	— 22.235050	2.8478429	— 3.8850819	106.32806	1328.3949	1.6230737
400	2.5278960	— 17.311330	33.502879	—126.25039	—203.32192	6.3932857	—21.611090	72.328160	1893.3822	— 5.9003314

$(K_i/T)^{1/3} = a_{i1} + a_{i2}T + a_{i3}T^2 + a_{i4}T^3$,(T in °R)
$(h_i)^{1/3} = c_{i1} + c_{i2}T + c_{i3}T^2$,(T in °R)
$(H_i)^{1/3} = e_{i1} + e_{i2}T + e_{i3}T^2$,(T in °R)

* Enthalpy and Equilibrium data taken from References 6 and 10, respectively.

Figure Distillation This New Way . . .

TABLE 12—Example 2

Specifications: $\sum_{i=1}^{3} d_i = 17.9723$, $V_1 = 94.8$

Plate Number	Temperature, °F. at Trial Number Given								
	1*	2	3	4	5	6	7	10	11
0 (Distillate)	108 47	111 06	113.07	111 34	109 26	108 13	107 71	107 60	107.60
1	142.53	146.00	145.35	140.86	137.02	135.14	134.52	134.42	134.42
2	170.93	173.35	167.94	159.89	154.48	152.35	151.89	151.99	152.00
3	206.86	204.66	190.34	177.57	171.39	170.01	170.13	170.38	170.35
4 (Feed)	296.20	270.35	231.34	209.30	204.86	206.93	208.11	207.54	207.47
5	291.37	277.75	252.12	234.77	228.73	228.34	228.83	228.82	228.77
6	286.99	281.75	264.35	251.01	244.97	243.48	243.39	243.38	243.36
7	286.78	284.81	272.68	262.37	256.79	254.83	254.35	254.21	254.19
8	288.00	288.15	279.39	271.15	266.09	263.97	263.25	262.95	262.94
9	292.16	292.93	286.37	279.60	275.10	272.99	272.16	271.75	271.74
10	300.42	301.01	296.15	290.75	287.14	285.34	284.58	284.17	284.17
11	316.56	317.35	314.76	311.79	309.78	308.74	308.28	308.03	308.02
12 (Reboiler)	366.01	367.45	368.71	368.30	367.52	367.00	366.75	366.61	366.60
$\sum_{i=1}^{3} d_i$	17.601	17.959	17.990	17.988	17.980	17.974	17.9721	17.97241	17.97235
D_{ca}	27.92**	31.62	35.11	33.58	32.12	31.630	31.571	31.610	31.607
Θ	0.065	0.676	2.893	2.367	1.398	1.045	0.991	1.004	1.002

* This profile was calculated on the basis of a distillate temperature of 100 F. with an increase of 10 F. per plate. All profiles other than the first one are averaged.
** A D of 17.9723 was assumed to make the first trial calculation.

TABLE 13—Example 3

Specification: $\sum_{i=1}^{3} X_{Di} = 0.56869461$, $V_1 = 94.8$

Plate Number	VAPOR RATE AT TRIAL NUMBER GIVEN							
	2*	3	4	5	6	7	8	9
1	94.8	94.8	94.8	94.8	94.8	94.8	94.8	94.8
2	85.3	89.2	91.3	92.4	92.9	93.1	93.2	93.3
3	85.3	84.9	86.9	88.3	88.9	89.2	89.3	89.4
4 (Feed)	85.3	76.4	77.6	79.5	79.8	80.0	80.0	80.1
5	79.0	94.8	112.5	112.1	111.3	111.0	110.8	110.8
6	101.1	121.3	125.4	125.4	125.6	126.0	126.2	126.2
7	113.8	133.7	135.2	135.2	135.7	136.2	136.6	136.8
8	113.8	136.5	141.8	143.0	143.5	143.9	144.2	144.3
9	113.8	136.5	145.6	148.0	148.6	148.7	148.8	148.9
10	113.8	136.5	146.7	149.3	149.8	149.7	149.6	149.5
11	113.8	136.5	142.3	144.0	144.2	144.1	143.9	143.8
12 (Reboiler)	118.8	119.2	121.7	122.8	123.3	123.5	123.5	123.5
$\sum_{i=1}^{3} X_{Di}$	0.53708	0.58553	0.56745	0.56692	0.56846	0.56874	0.56874	0.56877
Θ	2.68269	0.43545	1.05504	1.08081	1.01055	0.99815	0.99804	0.99900
D_{ca}	31.5564**	31.592	31.5956	31.6003	31.6023	31.6026	31.6026	31.6026

* Vapor rates assumed constant at 94.8 for the first two trials.
** A value of D = F/2 was assumed to make the first trial calculation.

TABLE 14—Example 4

Specifications: Temperature of Distillate (Vapor) = 107.5859F., $V_1 = 94.8$

Variable	TRIAL NUMBER								
	1	2	3	4	5	6	7	8	9
Temp.*, F., of Distillate	130.4567	107.2907	107.4681	107.5387	107.5669	107.5771	107.5825	107.5845	107.5854
Θ	1.79250	2.60646	0.40258	1.01791	1.07920	1.01365	0.99936	0.99822	0.99893
D_{ca}	32.4141	33.1671	30.4834	31.5961	31.6959	31.6182	31.6014	31.5998	31.6005
D_{co}	31.4702	31.4126	31.5298	31.5728	31.5955	31.6105	31.6022	31.6020	31.6019

* Dew point of the distillate when calculated on the basis of the $(d_i)_{ca}$'s.

each trial according to this procedure are given.

Instead of specifying the total distillate rate, as in Example 1, the dew point temperature of the distillate (obtained in the solution of Example 1) was specified in Example 4. Final results of the solution are shown in Table 14. A large number of significant figures was used in this temperature specification so that an exact comparison between Examples 1 and 4 could be made. Good agreement of all of the final results for the two examples was obtained.

ACKNOWLEDGMENT

The assistance given by G. W. Wilson, W. M. Harp and others of the Humble Oil & Refining Company is appreciated. The authors at the college wish to acknowledge the support given to them by the Texas Engineering Experiment Station and the assistance given by the staff of the Computing Center of the Experiment Station.

SYMBOLS USED

(See Part 1)

LITERATURE CITED

(See Part 1)

About the Authors

Lyster

Sullivan

Billingsley

Holland

William N. Lyster is a chemical engineer for Humble Oil & Refining Co., Baytown, Texas, where he handles applications of chemical engineering calculations on electronic computers. He joined the Technical division at Humble's Baytown refinery in 1953, was in military service from 1954-56—then rejoined Humble. Lyster has a professional degree in petroleum refining engineering from Colorado School of Mines.

S. L. Sullivan is a graduate student at Texas A & M College, where he received B.S. and M.S. degrees. He is a member of Tau Beta Pi, Phi Kappa Phi, Phi Lambda Upsilon and Sigma Chi.

D. S. Billingsley, is a graduate student at Texas A & M College, where he received B.S. degrees in chemical, industrial and mechanical engineering, and a M.S. degree in chemical engineering in January, 1958. An Army veteran, he is a member of Phi Lambda Upsilon and an associate member of Sigma Chi.

C. D. Holland of Texas A & M College, holds B.S. and M.S. degrees in chemical engineering from that school. He has experience in teaching and as an engineer for Columbia Southern Chemical Corp. and with the Air Force's Research and Development Command.

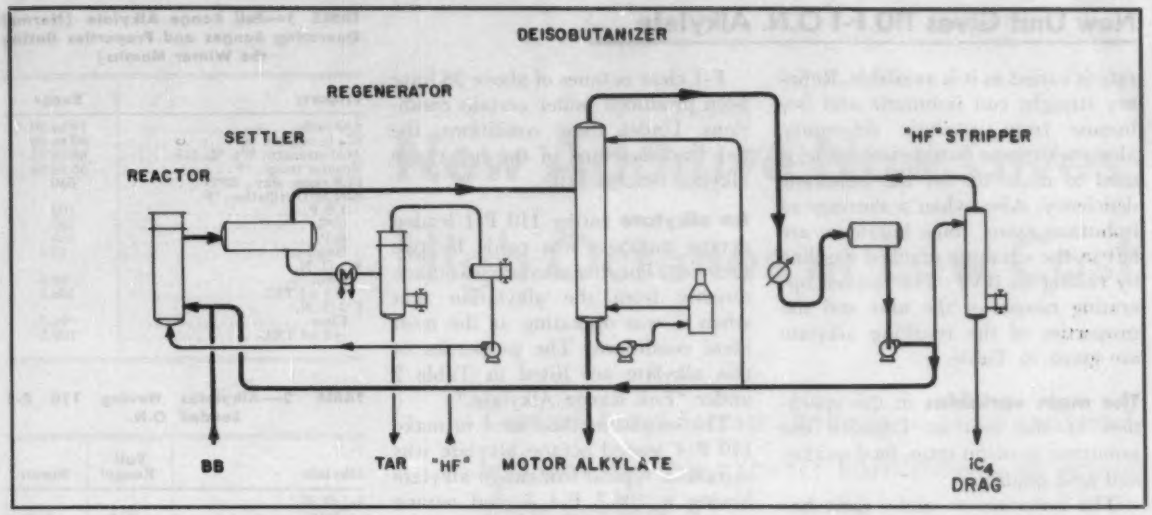


FIGURE 1—No bauxite towers are required for defluorination on any of the streams.

New Unit Gives 110 F-1 O.N. Alkylate

Latest design factors are incorporated in HF alkylation unit of Leonard refineries. Here is a description of the unit and its high octane product

Edwin K. Jones
Universal Oil Products Co.
Des Plains, Ill.

WE STILL are expanding our knowledge about many phases of alkylation although the process is relatively old. Many factors which were considered standard and which were used to design units have now been discarded as obsolete. In their place we are substituting new factors. The increased quality of the alkylate being produced today on the newer units confirms that these new factors are important in designing these units.

One of the latest "HF" alkylation units to take advantage of these new design factors is located at the Leonard Refineries in Alma, Mich. This unit was designed for the production of 1,000 bpd of motor alkylate made from B-B from catalytic cracking units. The installation cost of this unit was $850,000, which is $850 per barrel of alkylate at design throughput.

The flow diagram unit is shown in Figure 1. The B-B is taken from the bottom of a depropanizer in the refinery gas recovery section and charged to the alkylation unit reactor without any treatment or further drying. Before entering the reactor, the B-B is joined by the isobutane recycle from the deisobutanizer. The reactor is designed similar to a heat exchanger but employs a very efficient feed distributor of special design. There is no acid circulation as such, but only the acid returned from the regenerator, which stream is relatively small.

The reactor effluent is pressured, without pumping, through a settler, for separating the acid used as feed to the regenerator, and then is pressured to the deisobutanizer. In the deisobutanizer, the isobutane and small amount of dissolved HF pass overhead and are returned to the reactor, while the alkylate passes out the bottom to storage.

No bauxite towers are required for defluorination on any of the streams as the combined fluorides are very low. The full range alkylate stream contains less than 30 ppm of fluoride and the butane contains less than 20 ppm.

Propane is removed from the system by taking a drag stream of isobutane recycle through a small HF stripper and caustic scrubber and back to the depropanizer in the refinery gas recovery section. The isobutane is then returned to the contactor in the B-B feed.

The acid regenerator is merely a fractionator for separating the HF from the polymer and water. Because the constant boiling mixture of water and HF (CBM) is very corrosive, the regenerator column is monel clad and all exchanger bundles contain monel tubes.

Auxiliary equipment consists of a fresh acid tank, caustic scrubbers on the product streams and acid relief gases, and a lime neutralizing pit for drainage water.

Operation of the unit is quite simple with only two operators required at the unit at any time. The isobutane recycle is usually set at the desired flow rate and the olefinic feed

rate is varied as it is available. Refinery straight run isobutane and isobutane from catalytic reforming, along with some outside isobutane, is used to make up for the isobutane deficiency. Also, when a shortage of isobutane exists, some butylenes are left in the catalytic cracked gasoline by raising its RVP. The normal operating ranges of the unit and the properties of the resulting alkylate are given in Table 1.

The main variables in the operation of the unit at Leonard are isobutane to olefin ratio, feed quality and acid quality.

The isobutane to olefin ratio has been the greatest variable, being changed between 9 to 1 and 35 to 1. The F-1 octane numbers, both clear and leaded, continue to increase up to the higher ratios, but at decreasing rate. Low temperatures seem to give very little benefit at the higher ratios.

In the 18 to 1 isobutane to olefin ratio range, the F-1 clear octane numbers will vary from 96 to 97 with no visual change in operating conditions. However, the feed quality of the unit changes considerably, and it is felt that this is the main cause of the octane variation. The feed change is due to variable quantities of olefins left in the catalytic gasoline. Because the butylene-2 is the heavier olefin, it preferentially remains in the catalytic gasoline.

About the Author

Edwin K. Jones has been with Universal Oil Products Co. for 22 years as a chemical engineer. He has designed, constructed and operated refining units in Germany, France, England, Trinidad, Uruguay, Argentina, Canada and the United States. He currently coordinates operation of all polymerization and alkylation units for UOP. Jones holds a chemical engineering degree from Purdue University.

F-1 clear octanes of above 98 have been produced under certain conditions. Under these conditions, the F-1 leaded octane of the full range alkylate reaches 110.

An alkylate rating 110 F-1 leaded octane numbers was made by two methods. The first alkylate was taken directly from the alkylation unit when it was operating at the most ideal conditions. The properties of this alkylate are listed in Table 2 under "Full Range Alkylate."

The second method used to make 110 F-1 leaded octane alkylate was to take a typical full range alkylate having a 108.7 F-1 leaded octane and rerun it in the laboratory for the removal of 5 percent bottoms. The 95 percent fraction then had 110 octane. The properties of this alkylate after rerunning are listed in Table 2 under "Rerun Alkylate". The properties of the Leonard alkylate before rerunning are listed in Table 3.

In producing alkylate, the aim is to produce the highest percentage of alkylate having the highest possible octane number. In order to accomplish this, it is necessary to increase the quantity of trimethylpentanes in the product and decrease the quantity of the other components. A typical wartime HF alkylate with an F-1 clear octane of 91 contained 55 percent trimethylpentanes while a present day HF alkylate having an F-1 clear octane of 96 contains 77 percent trimethylpentanes.

The present alkylates show a definite decrease in C_9 contents as indicated by the Engler Distillation End Point being reduced from approximately 390°F. on alkylates of about two years ago, to about 358°F. on present day alkylates. The composition breakdown in Table 3 is for a high octane HF full range alkylate. Where this alkylate shows 4.6 liquid volume percent C_9, alkylates of several years ago contained 9 percent C_9.

Alkylate blending properties of a typical Leonard full range HF alkylate are shown in Table 4. The alkylate is blended with a 385° F. End Point catalytic gasoline to make a 103 F-1 leaded octane blend. It required 40 percent of the 108.7 octane alkylate to bring the 98.8 octane catalytic gasoline up to the 103 F-1 leaded octane level.

TABLE 1—Full Range Alkylate (Normal Operating Ranges and Properties During the Winter Months)

Property	Range
I/O ratio	10 to 20
iC_4 in recycle, %	90 to 98
Acid strength, Wt. %, HF	86 to 91
Reactor temp., °F	55 to 65
Full range alky., BPD	650
ASTM Distillation, °F	
I.B.P.	102
50%	220
E.P.	358
Rvp., psi	10.4
F-1 O. N.	
Clear	97.0
+3 ml TEL	108.7
F-2 O. N.	
Clear	94.2
+3 ml TEL	109.5

TABLE 2—Alkylates Having 110 F-1 Leaded O.N.

Alkylate	Full Range[1]	Rerun[2]
F-1 O. N.		
Clear	98.4	97.9
+3 ml TEL	110.0	110.0
F-2 O. N.		
Clear	95.0	94.4
+3 ml TEL	109.8	109.7
Rvp, psi	10.2	11.2
Gravity, °API	70.5	71.0
Engler Distillation		
I.B.P., °F	106	118
5 %	152	166
10%	184	184
30%	215	212
50%	220	217
70%	222	219
90%	358	224
95%	....	226
E.P.	358	244

[1] Full range alkylate made from unit when operating at ideal conditions.
[2] Alkylate made by rerunning a 97 F-1 clear alkylate to remove 5 percent bottoms.

TABLE 3—Typical Full Range 'HF' Alkylate

Components	Liq. Vol. %
Pentanes	1.6
Hexanes	1.3
Heptanes	2.0
Dimethylhexanes	13.7
Trimethylpentanes	76.8
Nonanes	4.6
	100.0

TABLE 4—Alkylate Blending

Property	Leonard 'HF' Alkylate	Light Cat. Gasoline	Blend[1]
F-1 O.N.			
Clear	97.0	92.3	95.3
+3 ml TEL	108.7	98.8	103.0
F-2 O.N.			
Clear	94.2	80.9	85.1
+3 ml TEL	109.5	86.8	93.7
Rvp, psi	11.0	7.1	10.9
Gravity, °API	73.5	63.7	67.5
Engler Distillation			
IBP, °F	94	118	89
5%	144	127	110
10%	176	133	121
30%	214	152	161
50%	219	185	201
70%	222	235	232
90%	244	308	295
95%	360	338	335
E.P.	360	385	385

[1] Blend contains 40 percent 'HF' alkylate blend with 60 percent light catalytic gasoline and butane to 10# Reid vapor pressure.

Original presentation was before the American Institute of Chemical Engineers—American Chemical Society Joint Meeting, Beaumont, Texas, March 13, 1959.

New Additive Now Gives High Octanes at Low Cost

Tertiary butyl acetate can be used as an antiknock additive having greater effectiveness as octane levels increase

A new additive, tertiary butyl acetate, is found to increase the antiknock rating of motor fuels. One of its outstanding features is its greater effectiveness at higher octane levels.

Laboratory and road octane ratings are given in this report to show you the amount of octane improvement to expect.

The cost of the additive has not been established on a commercial basis. Therefore, the economic calculations are tentative. They do, however, give indication that the additive will be a much cheaper approach to higher octanes than additional refinery processing.

Robert S. Aries
Aries Associates, Inc.
Stamford, Conn.

THE USE of cheap petrochemicals such as tertiary alkyl esters particularly tertiary butyl acetate effectively increases gasoline octane ratings. This additive used in amounts of 0.7 percent by volume constitutes a new class of anti-knock compounds and opens avenues for further research.

About 59 billion gallons of gasoline are consumed yearly in the United States. Since about 30 percent of that is premium gasoline which could potentially use tertiary butyl acetate, then over 17 billion gallons could use the additive economically in the future.

Octanes Go Up. In the United States in recent years, the average rate of octane increase has been over 1.0 Research octane number per year (at 3.0 ml TEL/gallon). Estimates indicate that the increase will continue, although at a slower rate of about 0.4 Research octane number per year. Most industrialized countries are already or are expected to follow the trend to higher octanes. In some countries a "third pump" has appeared at distributing stations which supplies a "super" gasoline with a higher octane rating than the premium grade.

The use of TEL is usually an economical means of increasing octane ratings, but it has some definite limitations. In the first place, while a small addition of TEL may cause a marked octane improvement, a second such small addition causes a lesser improvement. As a matter of experience long ago learned, it was found that about 3 ml. of TEL per U.S. gallon is the maximum which leads to important octane improvement, and since TEL is very toxic, this amount has been made the legal maximum, thus enacting into the law the technical conclusion that above 3 ml. of TEL further additions have relatively little value coupled with higher toxicity.

TEL has its greatest value with gasolines which have a low octane number. The advanced refining methods also are most effective in this range, so that these two methods are in a sense competitive and also additive. Usually the degree of advanced refining used is such that together with 3 ml. of TEL the desired octane rating is obtained.

But the octane race continues and each year sees a higher octane requirement for gasolines. Furthermore, most gasolines already contain 3 ml. of TEL per gallon so that continually increasing octane requirements have been met by installing increasingly expensive super-refining methods. Now, however, tertiary

butyl acetate can provide the final increase in octane rating, the ultimate increase which has hitherto required enormously expensive plants to produce.

A New Additive. Tertiary butyl acetate has the very important characteristic that it is most effective with gasolines that already have reached high octane values. It is most useful with highly aromatic gasolines which already contain the maximum allowable TEL. It is not particularly useful with low grade gasolines not containing TEL, but the higher the octane rating of the gasoline to which it is added, the bigger is the increase in octane rating which it achieves.

Tertiary butyl acetate is an organic chemical which is a liquid in the boiling range of gasoline, completely miscible with all gasolines, regardless of type. It is insoluble in water, so it cannot be washed out in storage. It is stable, non-toxic, noncorrosive, is compatible with all other additives being used in gasoline including anti-oxidants, rust inhibitors, upper cylinder lubricating oils, etc. It is without effect on the paint of automobiles, on gasoline hoses, tanks, etc.

TABLE 1—Additive Response of Base Gasoline

Additive (Vol. %)	Octane Number (Motor)	
	Rating	Gain
0	88.7	....
0.25	89.6	0.9
0.50	90.0	1.3
1.00	90.2	1.5

TABLE 2—Additive Response of Base Gasoline Plus Alkylate

Additive (Vol. %)	Octane Number (Motor)	
	Rating	Gain
0	91.7	....
0.25	92.5	0.8
0.50	93.3	1.6
1.00	93.2	1.5

TABLE 3—Additive Response in a 1958 Auto

Speed (RPM)	Octane Number (Modified Borderline At Part Throttle—10 In. Vac)		
	Without Additive	0.5 Vol. % Additive	Gain
1,000	94.7	95.1	0.4
2,250	91.8	92.3	0.5
2,500	90.6	92.1	1.5
3,000	90.2	91.9	1.7

TABLE 4—Cost of Using the Additive

Component	Cost (Dollars)		
	Volume (Gal)	Per Gal.	Total
Base	99.3	0.15	14.90
Additive	0.7	0.72	0.50
Blend	100.0		15.40

Cost of Blend = 15.4 cents per gallon (as compared to 15 cents per gallon for base).

A base gasoline containing 3 ml. TEL per gallon was doped with tertiary butyl acetate. The increase in Motor octane number ratings for various concentrations of additive is shown in Table 1.

When the base gasoline is upgraded with 25 percent alkylate and retained at 3 ml. TEL per gallon, the increases in octane numbers are as shown in Table 2.

Modified borderline ratings are shown in Table 3. These ratings were made in a 1958 standard car at part throttle (10 inches vacuum) on a motor fuel containing 2.9 ml. TEL per gallon.

The gain in octane numbers is less by the Research method than by the Motor method. However, the gain in automobile road performance is highest where it is most needed; namely, at part throttle and high speeds.

What It Will Cost. The economics of using tertiary butyl acetate cannot be established until the purchase price of the additive is fixed. The additive has not been manufactured on a large commercial scale and hence no commercial quotations are available at this time.

A tentative design and economic study indicates that tertiary butyl acetate can be made in large commercial quantities for about 10 cents per pound—72 cents per gallon. The optimum usage of the additive is about 0.7 percent by volume. Thus using the additive will increase the cost of gasoline by about 0.4 cents per gallon of gasoline as shown in Table 4.

Tertiary butyl acetate will increase a motor fuel of 100 Research octane number to 101, a motor fuel of 104 Research octane number to 105.5 and a gasoline of 107 will be increased to 109.5. A survey of present expansion plans by leading petroleum companies indicates that, on the average, facilities producing about 100 million barrels of gasoline per year must have an added investment of $350 million in new refining equipment to increase the octane rating of this gasoline 1.5 octane units. A plant to produce the 110,000 tons of t-butyl acetate which will raise the octane by the same amount will cost considerably less than $20 million.

The amortization per year of $350 million alone is far more than the total cost of the plant for producing t-butyl acetate and the cost of the materials used in producing the product. In fact, the United States will soon reach the point where more reforming capacity will not alter substantially the octane numbers, thus other methods will become imperative. Of course, it is not necessary to market 100 million barrels of gasoline per year (300,000 barrels per day) to get the benefits of the use of t-butyl acetate.

The manufacture of t-butyl acetate is simple and uses standard techniques and equipment. The raw materials are isobutylene and acetic acid, which are readily available large tonnage petrochemicals, and it can either be made at the refinery or by a chemical company. The use of t-butyl acetate is expected to play an important role in upgrading the octane quality of gasolines produced in the near future.

About the Author

Robert S. Aries, in addition to heading his own consulting firm, finds time for teaching a graduate course in chemical-engineering economics at Polytechnic Institute of Brooklyn. In his consulting work, Dr. Aries specializes in a combination of engineering and economics, devoting his skills to the analysis of such items as markets and products, processes and investments. He was educated at the University of Minnesota, Brooklyn Polytech and Yale and Columbia universities; he holds three engineering degrees, plus a master's degree in business administration.

Applied Hydrocarbon Thermodynamics

Part 11: Flow Calculations for Gases and Gas-Liquid Mixtures

Wayne C. Edmister*
California Research Corp., Richmond, Calif.

Milton Ludwig
Standard Oil of California, San Francisco

THE FLOW OF GASES and of gas-liquid mixtures, for which the density and temperature change appreciably with pressure, is an operation requiring the application of thermodynamic relationships and the exponents n′ and n, developed in Parts 7, 8, 9, and 10. Compressibility factors are also required. By using n′, n, and Z, the compressible fluid flow calculations are made for real, not ideal, gases.

Three types of compressible fluid flow are of interest.

1. **Nozzle Flow**—Fluid flow through a nozzle so that the pressure energy of the gas is converted to kinetic energy.
2. **Pipe Flow**—Fluid flow in a channel of uniform cross section with friction and, in some cases, heat transfer causing pressure drop and possible phase change.
3. **Diffuser Flow**—Fluid flow in which the kinetic energy of a high velocity gas is converted to pressure energy, i.e., the opposite of "nozzle flow."

The first two of these three fluid flow problems will be considered after deriving the basic equations for a steady flow system.

Energy Balances. Consider the steady flow system shown schematically in Figure 11.1 and equate the sum of the *input* energy terms to the sum of the *output* terms.

$$E_1 + P_1V_1 + \frac{U_1^2}{2g_c} + X_1\frac{g}{g_c} + Q = E_2 + P_2V_2 + \frac{U_2^2}{2g_c} + X_2\frac{g}{g_c} + W_s \qquad (11.1)$$

From which

$$\Delta E + \Delta(PV) + \frac{\Delta U^2}{2g_c} + \Delta X\frac{g}{g_c} = Q - W_s \qquad (11.2)$$

Combining Equation 11.2 with the definition of enthalpy $\Delta H = \Delta E + \Delta(PV)$ gives

$$\Delta H + \frac{\Delta U^2}{2g_c} + \Delta X\frac{g}{g_c} = Q - W_s \qquad (11.3)$$

Note: The energy units in Equations 11.1, 11.2, and 11.3 are "ft lb-force per lb-mass," sometimes called "feet of fluid flowing." The g/g_c ratio, following the elevation variable, X, is the local acceleration of gravity over a conversion constant.

Definition: $g_c = \frac{m}{F}g = \frac{\text{lb mass}}{\text{lb force}}\ \frac{\text{ft}}{\text{sec}^2}$

For a reversible nozzle the potential energy change is zero and so are the Q and W_s terms, giving

$$\Delta H = -\frac{\Delta U^2}{2g_c} \qquad (11.4)$$

Equation 11.4 is used with Mollier chart readings to find the nozzle exit velocity. This is usually done by assuming that the initial velocity is zero, giving

$$U = \sqrt{2g_c(H_1 - H_2)} \qquad (11.5)$$

Another nozzle flow formula will be derived later. Enthalpy in Equations 11.3 through 11.5 has the units of ft lb-force per lb-mass.

For most hydrocarbon fluids encountered in process design work, enthalpy charts are not available so Equation 11.3 will be combined with the statement of the first law of thermodynamics to eliminate H. Where only reversible work is involved

$$\Delta H = Q + \int V\,dP \qquad (8.1)$$

For a real process where there is friction

$$\Delta H = Q + \int V\,dP + F \qquad (11.6)$$

Where F = the friction term in same units as the other terms.

Combining Equations 11.3 and 11.6, cancelling the Q terms, and differentiating gives

$$V\,dP + dF + \frac{U\,dU}{g_c} + \frac{g}{g_c}dX = -d'W_s \qquad (11.7)$$

This is the differential form of the Bernoulli Theorum. When the potential energy and the shaft work terms are zero as in nozzle, horizontal pipe, and diffuser flows, Equation 11.7 becomes

$$V\,dP + \frac{U\,dU}{g_c} + dF = 0 \qquad (11.8)$$

Equation 11.8 shows the relationship between *pressure* energy, *kinetic* energy, and *friction*. This relationship will be used in solving compressible fluid flow problems.

When velocity change is negligible and shaft work is

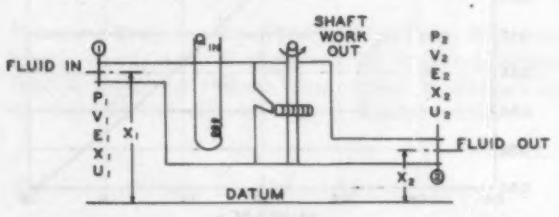


FIGURE 11.1—Schematic diagram of steady flow system for energy balance.

* Present address: Oklahoma State University, Stillwater, Okla.

zero, as in the case of a gas-lift oil well flow, Equation 11.7 becomes

$$VdP + dF + \frac{g}{g_c} dX = 0 \qquad (11.9)$$

This application will not be discussed here.

Nozzle Flow. Nozzles are designed to give a nearly frictionless flow so an ideal nozzle is the only case of present interest. From the nozzle inlet up to the throat, flow is generally assumed to be reversible and adiabatic even though acoustic velocity may be reached at this point.

Maximum flow will be obtained through a frictionless nozzle when the change in kinetic energy equals the change in the pressure energy. This occurs at a critical flow velocity, sometimes called acoustic or sonic velocity. At this point the pressure will be as low as it will go. The pressure would not drop below P_{CF}, the critical flow pressure, even if the nozzle discharged into a complete vacuum.

This critical flow pressure for an ideal adiabatic nozzle can be found from the isentropic exponent defining the volume change with pressure, i.e.,

$$P_1 V^n_1 = P_2 V^n_2 \qquad (7.6)$$

from which it was shown that

$$\int_1^2 VdP = P_1 V_1 \frac{n}{n-1} \left[\left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right] \qquad (8.17)$$

For the frictionless case Equation 11.8 is

$$VdP + \frac{UdU}{g_c} = 0 \qquad (11.10)$$

Integrating gives

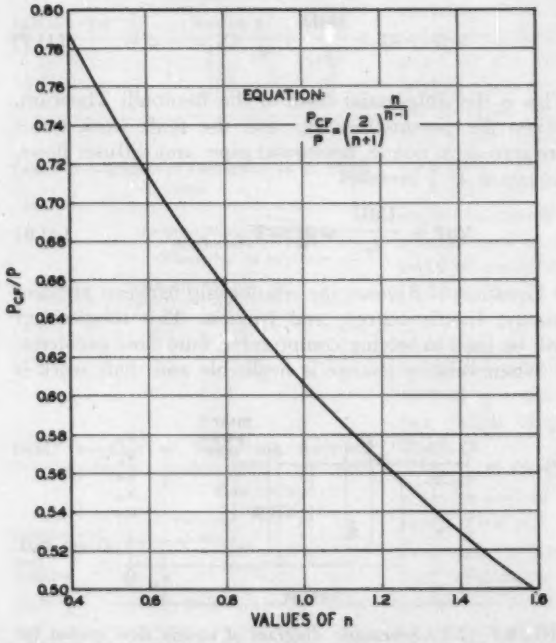


FIGURE 11.2—Critical flow pressure ratio for ideal nozzle.

$$\int_1^2 VdP = -\frac{\Delta U^2}{2g_c} \qquad (11.11)$$

Combining Equations 8.17 and 11.11, neglecting initial velocity and rearranging gives

$$\frac{U^2_2}{g_c n P_1 V_1} = \frac{2}{n-1} \left[1 - \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} \right] \qquad (11.12)$$

Leaving this expression until later and returning to Equations 7.6 and 11.10, from Equation 7.6

$$\frac{dP}{dV} = -n \frac{P}{V} \qquad (11.13)$$

From Equation 11.10

$$VdP = -\frac{G^2 VdV}{g_c} \qquad (11.14)$$

Where: $U = GV$
$dU = GdV$
$G =$ mass velocity
(When G = lb/sec-ft², V = cu ft/lb, U = ft/sec)

Combining Equations 11.13 and 11.14 gives the following two relationships for acoustic mass and acoustic linear velocities:

$$G^2 = g_c n \frac{P}{V} \qquad (11.15)$$

and

$$U^2 = g_c n PV \qquad (11.16)$$

Equations 11.15 and 11.16 give the velocity at the end of any line if the pressure beyond the line outlet is below the critical pressure, whether the flow is frictionless or not.

From Equation 11.16 it follows that

$$U^2_2 = g_c n P_2 V_2$$

Combining with Equation 11.12 gives

$$\frac{P_2 V_2}{P_1 V_1} = \frac{2}{n-1} \left[1 - \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} \right] \qquad (11.17)$$

The left-hand side of Equation 11.17 is equal to $\left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}}$

Substitution, rearranging and identifying P_2 as P_{CF} gives

$$\frac{P_{CF}}{P_1} = \left(\frac{2}{n+1} \right)^{\frac{n}{n-1}} \qquad (11.18)$$

Figure 11.2 is a graphical solution to Equation 11.18 and gives the critical flow pressure ratio for ideal nozzles as a function of the n value for the gas.

The maximum rate of flow through the nozzle is a function of the critical flow velocity and pressure. Writing Equation 11.15 for the mass velocity at the nozzle throat and elminating $(P/V)_{CF}$ by means of Equations 11.18 and 7.6 gives the mass velocity in terms for upstream or nozzle inlet conditions.

$$V_{CF} = V_1 \left(\frac{P_1}{P_{CF}} \right)^{1/n} = V_1 \left(\frac{n+1}{2} \right)^{\frac{1}{n-1}}$$

$$P_{CF} = P_1 \left(\frac{2}{n+1} \right)^{\frac{n}{n-1}}$$

$$\left(\frac{P}{V} \right)_{CF} = \left(\frac{P}{V} \right)_1 \left(\frac{2}{n+1} \right)^{\frac{n+1}{n-1}} \qquad (11.19)$$

Combining Equations 11.15 and 11.19 gives

$$G_{max} = \sqrt{g_c n P_1 \rho_1 \left(\frac{2}{n+1}\right)^{\frac{n+1}{n-1}}} \qquad (11.20)$$

Where: $\rho_1 = 1/V_1$ = density
G_{max} = lb/sec-ft²

Equation 11.20 for critical flow in a nozzle may also be derived by differentiating the mass flow units form of Equation 11.12, which is

$$G^2 = 2g_c P_1 \rho_1 \left(\frac{n}{n-1}\right)\left(\frac{P_2}{P_1}\right)^{2/n}\left[1-\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}\right] \qquad (11.12A)$$

For maximum flow

$$\frac{dG^2}{d\left(\frac{P_2}{P_1}\right)} = 0 = 2g_c P_1 \rho_1 \left(\frac{n}{n-1}\right)\left[\frac{2}{n}\left(\frac{P_2}{P_1}\right)^{\frac{2-n}{n}} - \frac{n+1}{1}\left(\frac{P_2}{P_1}\right)^{1/n}\right]$$

From which Equation 11.18 follows. Substitution of Equation 11.18 into Equation 11.12A gives Equation 11.20.

When n = 1.0 Equations 11.12A and 11.20 becom

$$G^2 = 2g_c P_1 \rho_1 \left(\frac{P_2}{P_1}\right)^2 \ln \frac{P_1}{P_2} \qquad (11.12B)$$

and

$$G_{max} = \sqrt{\frac{g_c P_1 \rho_1}{e}} = 0.605 \sqrt{g_c P_1 \rho_1} \qquad (11.20A)$$

The density term in Equation 11.20 will be replaced and the equation rearranged.

$$\rho = \frac{PM}{ZRT} \qquad (11.21)$$

P = pressure, lb/sq ft
M = molecular weight
Z = compressibility factor
R = gas constant = 1544
T = temperature, °R

Equation 11.21 gives ρ in lb/cu ft. Combining Equations 11.20 and 11.21, introducing a nozzle discharge coefficient, K, and rearranging

$$W = 3600 \sqrt{\frac{32.2}{1544}} \cdot \sqrt{n\left(\frac{2}{n+1}\right)^{\frac{n+1}{n-1}}} \cdot KAP\sqrt{\frac{M}{ZT}} \qquad (11.22)$$

Where: W = rate of flow in lb/hr

Equation 11.22 has been applied to the calculation of flow through nozzles to pressure relieving systems. For this application a gas coefficient has been plotted against n and Equation 11.22 has been in the following form

$$W = C\,K\,A\,P\sqrt{\frac{M}{ZT}} \qquad (11.23)$$

Where:

$$C = 520\sqrt{n\left(\frac{2}{n+1}\right)^{\frac{n+1}{n-1}}} \qquad (11.24)$$

K = Discharge coefficient (about 0.95 for a well designed nozzle)

The units of A and P must be consistent. If lb/sq in. units are used for pressure, then A is in square inches.

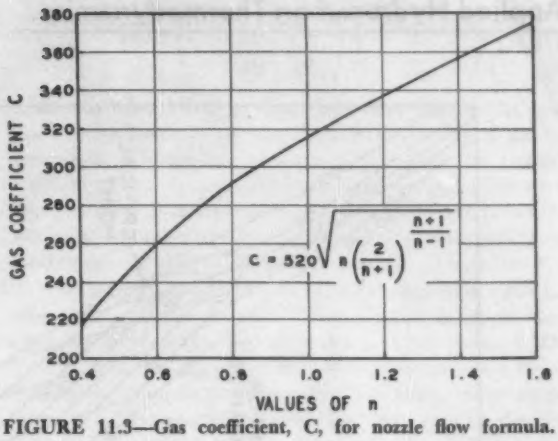


FIGURE 11.3—Gas coefficient, C, for nozzle flow formula.

Figure 11.3 is a plot of Equation 11.24, giving C as a function of n. This chart and equation apply to an ideal frictionless nozzle, the same as does Figure 11.2 for the critical flow pressure. The temperature and pressure conditions and the compressibility factor and exponent of the gas are at the nozzle inlet.

The nozzle flow equations and charts have been developed previously. One application has been to the problem of sizing pressure-relieving systems for pressure vessels in refinery service. (See API RP 520, September 1955.)

In this application, the problem is to size the nozzle for a flow rate equal to the rate of hydrocarbon vaporization in the vessel while exposed to fire. The rate of heat absorption, an important part of the design calculations, is beyond the scope of this article. When properly sized, the safety valve will open at the design pressure and the vapors will flow through the nozzle, reaching acoustic velocity at the outlet; and the pressure in the vessel will not exceed the design value.

Vapors leaving the vessel via the nozzle will be saturated (at dew point). During the vaporization of a wide boiling hydrocarbon liquid mixture at constant pressure (i.e., the safety valve setting), the dew point temperature will increase as the composition of the vapors being generated changes to higher concentrations of the heavier components. With sufficient heat input to keep the vapors at their dew point, the temperature will increase.

The value of n for a given hydrocarbon increases with increasing temperature. Increasing molecular weight, for the same temperature and pressure, reduces the n value. Thus, these effects are in opposite directions so the initial conditions (temperature, pressure and hydrocarbon composition) may be used with sufficient accuracy to find n for safety valve nozzle calculations.

Pressure Drop for Gas Flow in Pipe Line. When the kinetic energy term is neglected the equation for gas flow in a pipe of uniform cross section is obtained by starting with the following form of Equation 11.8.

$$VdP + dF = 0 \qquad (11.25)$$

The friction term is a function of friction factor

$$dF = \frac{f}{2g_c D} U^2 dL \qquad (11.26)$$

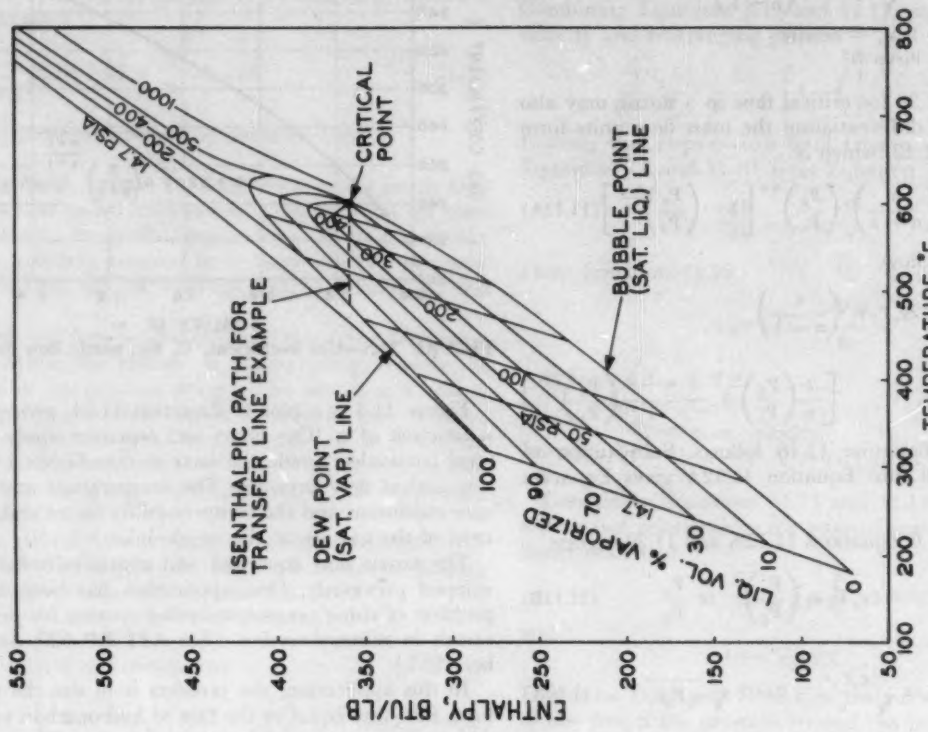


FIGURE 11.5—Enthalpy-temperature diagram for petroleum naphtha.

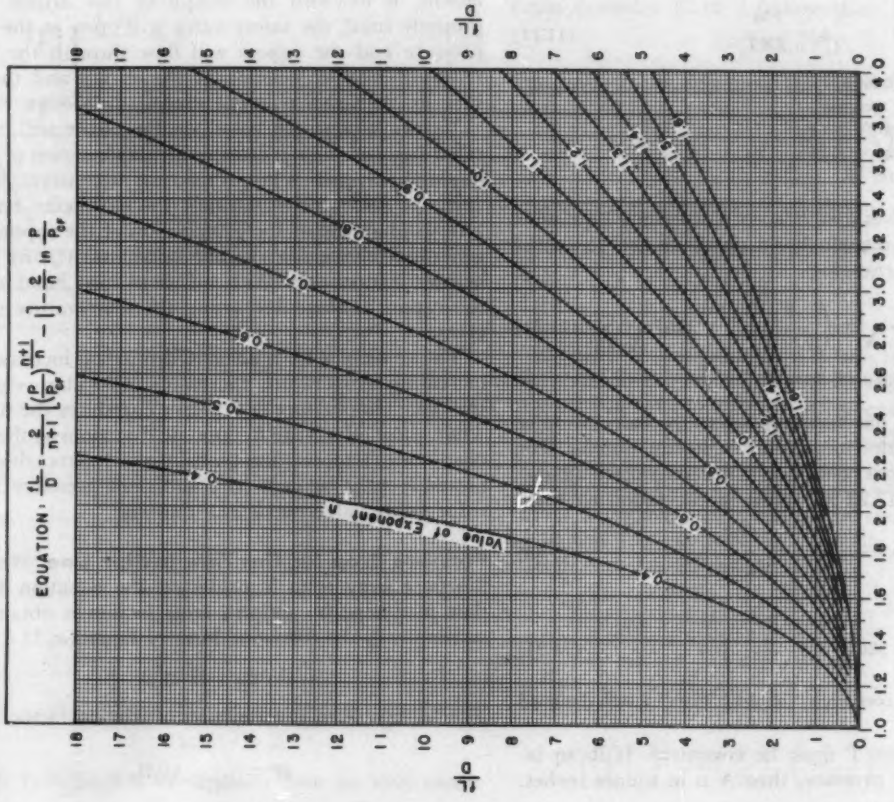

EQUATION: $\frac{fL}{D} = \frac{2}{n+1}\left[\left(\frac{P}{P_{cr}}\right)^{\frac{n+1}{n}} - 1\right] - \frac{2}{n}\ln\frac{P}{P_{cr}}$
Value of Exponent n
$\frac{P}{P_{cr}}$ = Inlet Pressure / Critical Flow Pressure
$\frac{fL}{D}$

FIGURE 11.4—Graphical solution of equation 11.40.

In terms of friction factor, f, and gas density, ρ, Equation 11.25 becomes

$$\frac{dP}{dL} = -\frac{fU^2\rho}{2g_cD} \qquad (11.27)$$

Where: f = Darcy-Weisbach friction factor defined by this equation and is four times the magnitude of the Fanning friction factor, which is defined in terms of hydraulic radius instead of diameter.
ρ = gas density, lb/cu ft
D = pipe diameter in feet
g_c = 32.2
U = velocity in feet/sec

Equation 11.27 is put in more convenient form by replacing ρ and U by their equivalents

$$\rho = \frac{PM}{ZRT} \text{ and } U = \frac{G}{\rho} = \frac{GZRT}{PM}$$

and

$$PdP = -\frac{fZRTG^2}{2g_cDM}\,dL \qquad (11.28)$$

Integrating from P_1 (at L = 0) and rearranging

$$G^2 = \frac{g_cDM}{ZRTf}\left(\frac{P^2_1 - P^2_2}{L}\right) \qquad (11.29)$$

A general equation, including a term for kinetic energy change, for gas flow in a pipe of uniform cross section is obtained by starting with Equation 11.8. This development will be shown in detail.

Combining Equations 11.8 and 11.26 gives

$$VdP + \frac{UdU}{g_c} + \frac{f}{2g_cD}U^2dL = 0 \qquad (11.30)$$

Make the following substitutions: U = GV and dU = GdV, divide by V and solve for — dP, giving

$$-dP = \frac{G^2}{g_c}\left[\frac{Vf}{2D}dL + dV\right] \qquad (11.31)$$

Replace V by $1/\rho$ and dV by $d\frac{1}{\rho} = -\frac{d\rho}{\rho^2}$

$$-\rho dP = \frac{G^2}{g_c}\left[\frac{f}{2D}dL - \frac{d\rho}{\rho}\right] \qquad (11.32)$$

Integrating and solving for G^2

$$G^2 = \frac{2g_c\int_{P_2}^{P_1}\rho dP}{\frac{fL}{D} + 2\ln\frac{\rho_1}{\rho_2}} \qquad (11.33)$$

Equation 11.33 is a general solution to Equation 11.8. It will next be put into more convenient form for the calculation of isothermal flow of gas in a pipe line. Later it will be used in another application.

Replacing the density terms by $\rho = PM/ZRT$ and $\rho_1/\rho_2 = P_1/P_2$, the latter being limited to isothermal flow conditions, gives

$$G^2 = \frac{\frac{2g_cM}{ZRT}\int_{P_2}^{P_1}PdP}{\frac{fL}{D} + 2\ln\frac{P_1}{P_2}} \qquad (11.34)$$

Integrating and rearranging gives the following desired equation

$$G^2 = \frac{g_cMD}{ZRTf}\left(\frac{1}{1 + \frac{2D}{fL}\ln\frac{P_1}{P_2}}\right)\left(\frac{P^2_1 - P^2_2}{L}\right) \qquad (11.35)$$

Transfer Line Flow of Gas and Gas-Liquid. In furnace-to-column transfer lines, the flow velocity of gas or gas-liquid mixture may approach or equal the critical velocity so that it is necessary to make proper allowance for the kinetic energy change. Flow will not occur at constant temperature so the simplifying assumption of isothermal conditions cannot be made.

The principal objective of transfer line flow calculations is to size the transfer line so that its inlet pressure does not exceed the desired furnace outlet pressure. Of course, it is not necessary that the outlet pressure be as low as the column pressure, which, in many cases, operates at a substantial vacuum. The first step in the design of a transfer line is to determine the critical outlet pressure for the tentatively chosen line size.

It will be assumed that a gas-liquid mixture behaves essentially the same as a gas of the same density so that the same flow equations can be used. This is in accord with actual experience when the flow is turbulent and the velocity is high enough to keep the liquid and gas moving at substantially the same velocity. These conditions are fulfilled in the usual transfer line from an oil vaporization furnace to a fractionating column. The friction factor will vary from 0.020 to 0.025 but may be taken as 0.025 for design calculations.

An expression for the critical flow pressure in terms of the mass velocity, fluid density and expansion exponent is obtained by applying Equation 11.15 at critical flow point

$$P_{CF} = \frac{G^2}{g_c\rho n} \qquad (11.36)$$

The value of n (defined by PV^n = constant for the flowing fluid and conditions) may be estimated from the charts in previous installments or it may be found from a knowledge of the pressure and volume changes during flow. The value of the density, ρ, is a function of the pressure, P_{CF}, i.e., ρ is the density of the fluid at the critical flow point.

Successive approximations are required to find ρ, n and P_{CF}. Besides Equation 11.36, an enthalpy balance calculation is involved in these calculations. For the latter, it is assumed that the flowing fluid is at constant enthalpy as it flows in the transfer line. This is very nearly correct as the flow is irreversible and adiabatic.

With this isenthalpic condition as a basis, it is possible to find the changes of volume and temperature with pressure. A method of determining the vapor-liquid phase relations for the fluid at various pressures and temperature is required. These data are then used with Equation 11.31 to find P_{CF}. This is illustrated by an example later.

An equation relating pressures, expansion exponent, and a fluid friction parameter is obtained from Equation 11.33. This development will be shown in detail. The $\int_2^1 \rho\,dP$ and $\ln(\rho_1/\rho_2)$ terms in Equation 11.33 are transformed by combining with $PV^n = C$ giving

$$\int_2^1 \rho dP = \frac{1}{C^{1/n}}\int_2^1 P^{1/n}\,dP = \frac{1}{C^{1/n}}\left(\frac{n}{n+1}\right)\left[P^{\frac{n+1}{n}}\right]_2^1$$

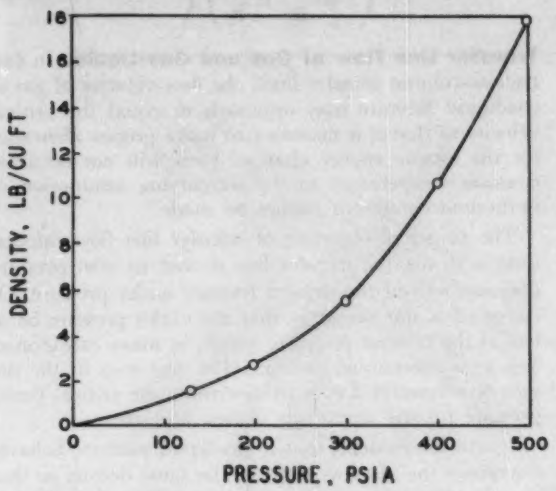


FIGURE 11.6—Density-pressure for isenthalpic path of naphthas in transfer line example problems.

Replacing $C^{1/n}$ by its equivalent $VP^{1/n}$ and writing the value of the integral for the limits gives

$$\int_2^1 \rho dP = \frac{n}{n+1}\left[\rho_1 P_1 - \rho_2 P_2\right] = \frac{n}{n+1}\rho_2 P_2 \left[\left(\frac{P_1}{P_2}\right)^{\frac{n+1}{n}} - 1\right] \quad (11.37)$$

In like manner

$$\ln \frac{\rho_1}{\rho_2} = \ln \left(\frac{P_1}{P_2}\right)^{1/n} = \frac{1}{n} \ln \frac{P_1}{P_2} \quad (11.38)$$

Combining Equations 11.33, 11.37, and 11.38 gives the following

$$G^2 = \frac{\frac{2n}{n+1} g_c \rho_2 P_2 \left[\left(\frac{P_1}{P_2}\right)^{\frac{n+1}{n}} - 1\right]}{\frac{fL}{D} + \frac{2}{n} \ln \frac{P_1}{P_2}} \quad (11.39)$$

Where: Subscript 1 refers to the furnace end of transfer line. Subscript 2 refers to the column end of the transfer line, i.e., critical flow velocity point.

Combining Equations 11.36 and 11.39, to eliminate G^2, and rearranging gives

$$\frac{fL}{D} = \frac{2}{n+1}\left[\left(\frac{P}{P_{CF}}\right)^{\frac{n+1}{n}} - 1\right] - \frac{2}{n} \ln \frac{P}{P_{CF}} \quad (11.40)$$

Equation 11.40 gives (fL/D) as a function of (P/P_{CF}) and n. This relationship is represented graphically on Figure 11.4. The coordinates of this chart are the values at the flow condition where friction losses and changes in pressure and kinetic energy just balance to give critical velocity flow at the transfer line.

Transfer Line Examples. Two examples will be solved to illustrate the calculation method. Both examples are for a 66° API naphtha, for which an enthalpy chart was available. In the first example the critical pressure is above the column pressure, while in the second P_{CF} is below the column pressure. Following are the flow conditions for these examples:

Material: 66° API naphtha

ASTM Distillation:

Point:	IBP	10%	30%	50%	70%	90%	FBP
T° F.:	130	190	240	280	320	360	400

Rate: 50,000 bpd

Furnace Outlet: 600 F. and 500 psia

Tower Pressure: 200 psia

Given: (1) Enthalpy—temperature diagram on Figure 11.5

(2) Friction factor f = 0.025

(3) Isenthalpic (irreversible and adiabatic) flow of naphtha in transfer line.

Using the enthalpy-temperature plot on Figure 11.5 and other data on liquid and vapor densities, compressibility factors, molecular weights, etc., densities of the vapor-liquid mixtures were calculated at five points on the constant enthalpy line shown dashed on Figure 11.5.

From these densities and the pressures, the values of the exponent n were computed for the four intervals. These calculations are given in Table 11.1. The density and exponent results are plotted against pressure in Figures 11.6 and 11.7.

Example I. Assume a 4.026-inch (4-inch schedule 40) transfer line with an equivalent length of 100 feet.

Rate of flow = 145.2 lb/sec

Flow area = 0.0884 sq ft

$G = 145.2/0.0884 = 1640$ lb-mass/sec-ft²

$$P_{FF} = \frac{G^2}{g_c \rho n} = \frac{83{,}500}{\rho n}$$

P_{CF} can now be determined by trial and error from Figures 11.6 and 11.7.

Pressure, psia	ρ lb/cu ft	n	P_{CF}, lb/sq ft	P_{CF}, lb/sq in
200	2.4	0.70	49,600	343
250	4.0	0.57	36,600	255

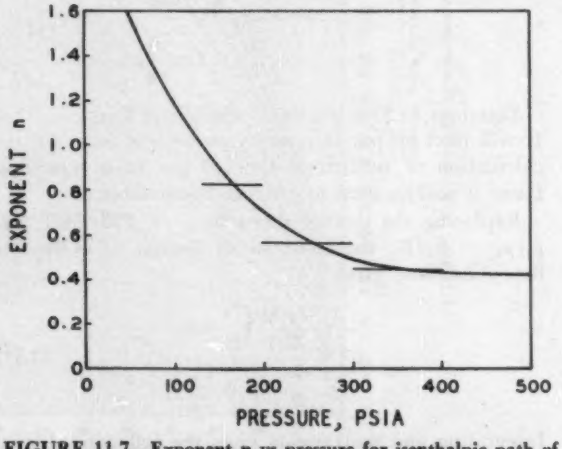


FIGURE 11.7—Exponent n vs pressure for isenthalpic path of naphtha in transfer line example problem.

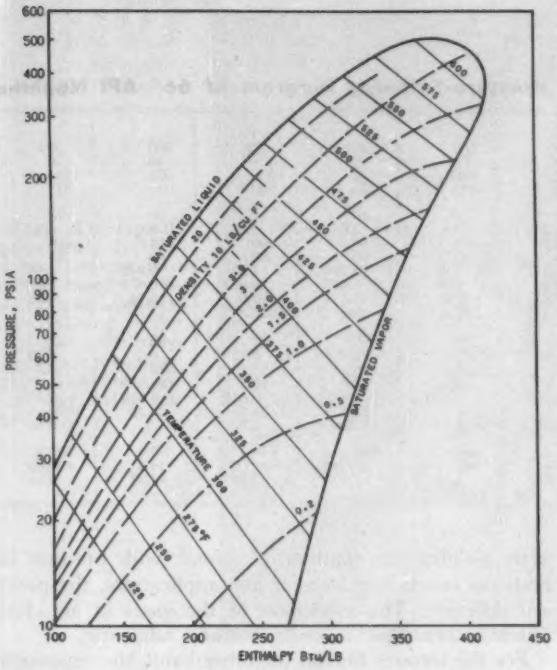


FIGURE 11.8—Pressure-temperature diagram for petroleum naphtha.

The critical outlet pressure is obviously between 250 psia and 255 psia—say 252 psia.

$$\frac{fL}{D} = \frac{(0.025)\ (100)}{\left(\frac{4.026}{12}\right)} = 7.47$$

To be conservative, assume that the value of n throughout the line is equal to the outlet value of 0.57. Then, from Figure 11.4, $P/P_{CF} = 2.22$ at the start of the line. Then, $P_1 = (2.22)\ (252) = 560$ psia vs 500 psia given.

Example II. The inlet pressure for a 4-inch line is higher than the desired inlet pressure of 500 psia so now consider a 6-inch schedule 40 transfer line for which the flow area is 0.201 sq ft.

$$G = 145.2/0.201 = 722 \text{ lb/sec-ft}^2$$

$$P_{CF} = \frac{G^2}{g_c \rho n} = \frac{16{,}200}{\rho n}$$

The critical outlet pressure is obviously below the column pressure of 200 psia. Nevertheless, its determination will aid in the calculation of the furnace outlet pressure. Assume n = 0.70, the value for the column pressure of 200 psia, which will also be the line outlet pressure. The density at 200 psia is 2.4 lb per cu ft. Then,

$$\rho_{CF} = 2.4\left(\frac{P_{CF}}{(200)\ (144)}\right)^{1/0.70}, \text{ and } P_{CF} = \frac{16{,}200}{(\rho_{CF})\ (0.70)}$$

$$(P_{CF})^{1+1/0.70} = \frac{16{,}200}{(2.4)\ (0.70)}\left[(200)\ (144)\right]^{1/0.70} = 2.27 \times 10^{10}$$

$$P_{CF} = 18{,}200 \text{ psfa} = 127 \text{ psia}$$

One may now calculate the initial line pressure by adding to the actual fL/D the additional fL/D that would be required to drop the pressure from the actual line outlet pressure of 200 psia to the critical pressure of 127 psia. To calculate this added length parameter, note that 200/127 = 1.57 and from Figure 11.4, read a value of fL/D = 1.0 for n = 0.70. The value of fL/D for the actual line is

$$\frac{0.025 \times 100}{6.065/12} = 4.94$$

The total value of fL/D, figured back from the critical pressure point, is 4.94 + 1.0 = 5.94 for which P/P_{CF} = 2.38 for n = 0.70. The inlet pressure for the 6-inch line is then 2.38 × 127 = 302 psia, well below the permissible maximum of 500 psia.

Some readers may not feel altogether satisfied with the preceding analysis as applied to mixture flow since the actual value of n increases as the pressure drops whereas the curves of Figure 11.4 are derived for con-

TABLE 11.1—Calculation of Densities and Exponents of 66° API Naphtha for An Isenthalpic Expansion

POINT / INTERVAL	1	1–2	2	2–3	3	3–4	4	4–5	5
Readings From Figure 11.5									
Pressure, psia	500	....	400	....	300	....	200	....	130
Vaporization, Liq. Vol. %	0	....	32	....	50	....	84	....	100
Temperature, F	600	....	580	....	556	....	520	....	483
Enthalpy, Btu/lb	365	....	365	....	365	....	365	....	365
Vapor Portion									
Gallons	0	....	32	....	50	....	84	....	100
°API	.....	....	76	....	74	....	68	....	66
Lb/gal	.....	....	5.676	....	5.731	....	5.904	....	5.964
Lb	.....	....	181.5	....	286.8	....	496.0	....	596.4
Molecular Weight	.....	....	65	....	70	....	88	....	104
Z	.....	....	0.53	....	0.65	....	0.73	....	0.80
ρlb/cu ft	.....	....	4.40	....	2.97	....	2.29	....	1.67
Cu ft vapor	.....	....	41.2	....	96.6	....	216.8	....	357.3
Liquid Portion									
Gallons	100	....	68	....	50	....	16	....	0
°API	66	....	62	....	60	....	58	....	.....
Lb/gal	5.964	....	6.087	....	6.151	....	6.216	....	.....
Lb	596.4	....	414.0	....	307.5	....	99.4	....	.....
$\rho_{T,P}/\rho_{60,0}$	0.40	....	0.60	....	0.64	....	0.70	....	.....
ρ, lb/cu ft	17.85	....	27.3	....	29.3	....	42.5	....	.....
Cu ft liquid	33.4	....	15.16	....	10.45	....	2.33	....	.....
Vapor-Liquid Mixture									
Total lb	596.4	....	596.4	....	596.4	....	596.4	....	596.4
Total cu ft	33.4	....	56.4	....	107.1	....	219.1	....	357.3
ρ_{mix} lb/cu ft	17.85	....	10.59	....	5.57	....	2.73	....	1.67
P_i/P_{i+1}	.....	1.250	.....	1.333	.....	1.500	.....	1.539	.....
ρ_i/ρ_{i+1}	.....	1.687	.....	1.900	.....	2.045	.....	1.633	.....
Exponent n-Intervals	.....	0.427	.....	0.448	.....	0.567	.....	0.826	.....
Exponent n-Points*	0.42	....	0.44	....	0.50	....	0.70	....	1.00

* From Figure 11.7

TABLE 11.2—Sample Calculations of Densities for Pressure-Enthalpy Diagram of 66° API Naphtha

Readings From Figure 11.5								
Pressure, psia	50	50	100	100	200	200	300	300
Vaporization, Liq. Vol. %	10	70	10	70	10	70	10	70
Temperature, F	310	362	382	438	467	510	528	565
Enthalpy, Btu/lb	177	270	220	310	273	344	313	372
Vapor Portion								
Gallons	10	70	10	70	10	70	10	70
Lb/gal	5.6	5.8	5.6	5.8	5.6	5.8	5.6	5.8
Lb	56	406	56.0	406	56.0	406	56.0	406
Molecular Weight	60	83	60	83	60	83	60	83
Lb moles	0.934	4.90	0.934	4.90	0.934	4.90	0.934	4.90
Z	0.85	0.88	0.75	0.80	0.625	0.685	0.475	0.565
ZRT/P	140.4	155.1	67.8	77.0	31.1	35.6	16.76	20.72
Cu ft vapor	131.2	760.0	63.3	377.3	29.0	174.5	15.7	101.6
Liquid Portion								
Gallons	90	30	90	30	90	30	90	30
Lb/gal	6.0	6.19	6.0	6.19	6.0	6.19	6.0	6.19
Lb	540	185.7	540	185.7	540	185.7	540	185.7
Lb/cu ft at 60. 0	44.9	46.3	44.9	46.3	44.9	46.3	44.9	46.3
$\rho_{T,P}/\rho_{60,0}$	0.820	0.775	0.760	0.715	0.657	0.625	0.518	0.500
Lb/cu ft	36.8	35.9	34.1	33.1	29.5	28.5	23.28	23.15
Cu ft liquid	14.66	5.18	15.84	5.62	18.32	6.52	23.2	8.03
Vapor-Liquid Mixture								
Total lb	596.4	596.4	596.4	596.4	596.4	596.4	596.4	596.4
Total cu ft	145.86	765.18	79.14	382.92	47.32	181.02	38.9	109.63
ρ_{mix}, lb/cu ft	4.09	0.78	7.54	1.56	12.60	3.29	15.33	5.44

stant values of n. The assumption that n is constant at the value existing at the line exit therefore leads to high calculated values for the line inlet pressure. This small error is, however, of little significance for engineering purposes and is trivial compared to the large errors that can, and do, result from grossly improper methods of calculation.

In actual practice most transfer lines with critical outlet pressures above the column pressure are lines to vacuum columns. Such lines are much larger, and often fabricated from costly alloy steel, so that proper sizing is of great importance.

Enthalpy-Pressure Diagram. Finding values of the expansion exponent n for gas-liquid mixtures is a large part of the work required in making transfer line flow calculations. This is illustrated by Table 11.1 and Figures 11.5, 11.6, and 11.7. In designing a transfer line it may be necessary to make several trials, each requiring different values of the exponent n.

When several sets of starting conditions are to be used for the same oil it is convenient to have a pressure-enthalpy diagram for the two phase region of the oil. Lines of constant density are necessary. Such a plot has been constructed for the 66° API naphtha used in the above examples. This plot is given as Figure 11.8. Enthalpies and phase conditions were taken from Figure 11.5. Samples of the readings from Figure 11.5 and the density calculations are given in Table 11.2.

Only the two phase (vapor and liquid) region has been drawn on Figure 11.8. Lines of constant temperature and constant density are included. Lines of constant percentage vaporized have been omitted. Such charts make transfer line calculations much easier.

Discussion. Both Figures 11.2 and 11.4 are exponent vs pressure ratio relationships. In Figure 11.2, for ideal nozzles, friction is zero and so is the initial velocity. In Figure 11.4, for transfer line flow, a variable friction term and the effect of a finite initial velocity are included.

Because of the initial velocity difference between these two cases, Figure 11.2 cannot be regarded as a special case of Figure 11.4 with (fL/D) equal zero.

Although the symbol n has been used for the exponent defining the changes of volume with pressure in both the nozzle and transfer line applications, the paths are different. The expansion of the gases in an ideal nozzle is *isentropic* or reversible and adiabatic.

For the transfer line on the other hand, the expansion is isenthalpic or irreversible and adiabatic. As shown in Part 8, the *isenthalpic* value of n is always lower than the *isentropic* n, for the same fluid, temperature, and pressure.

Actually, the expansion of the gas-liquid mixture in a transfer line is somewhere between isenthalpic and isentropic, since there is a substantial change of kinetic energy, especially for short lines. One can, however, state that the density-pressure relation for a mixture is not materially different for isentropic and isenthalpic expansions and that the assumption of isenthalpic expansion always leads to lower calculated densities as the pressure drops so that the calculated line capacity is always conservative, or low, if one assumes isenthalpic expansion; the actual difference is, however, trivial.

SYMBOLS

Along with the following symbols and definitions, typical engineering units are given. Any consistent set of units can be used, however.

- A = area, sq ft
- P = pressure, lb-force/sq ft
- T = temperature, °Rankine
- R = gas constant, 1544
- M = molecular weight
- g = local acceleration due to gravity
- g_c = 32.2, a conversion constant, $\frac{\text{lb mass}}{\text{lb force}} \times \frac{\text{ft}}{\text{sec}^2}$
- X = elevation, feet
- V = volume, cu ft/lb-mass
- $\rho = 1/V$ = density, lb-mass/cu ft
- U = linear velocity, ft/sec
- G = mass velocity, lb mass/sec-ft²
- H = enthalpy, ft lb-force/lb-mass in equations, Btu/lb-mass on Figure 11.5 and 11.8
- $E = H - PV$ = energy, same units as H
- Q = heat added to fluid, same units as H
- W_s = shaft work done by the fluid, same units as H
- F = friction, same units as H
- f = friction factor
- n = exponent in PV^n = constant
- Z = compressibility factor, dimensionless. ($Z = PV/RT$ in consistent units or MPV/RT in above units.)
- d = differential operator
- d' = inexact differential operator

Part 12 will appear in an early issue of REFINER

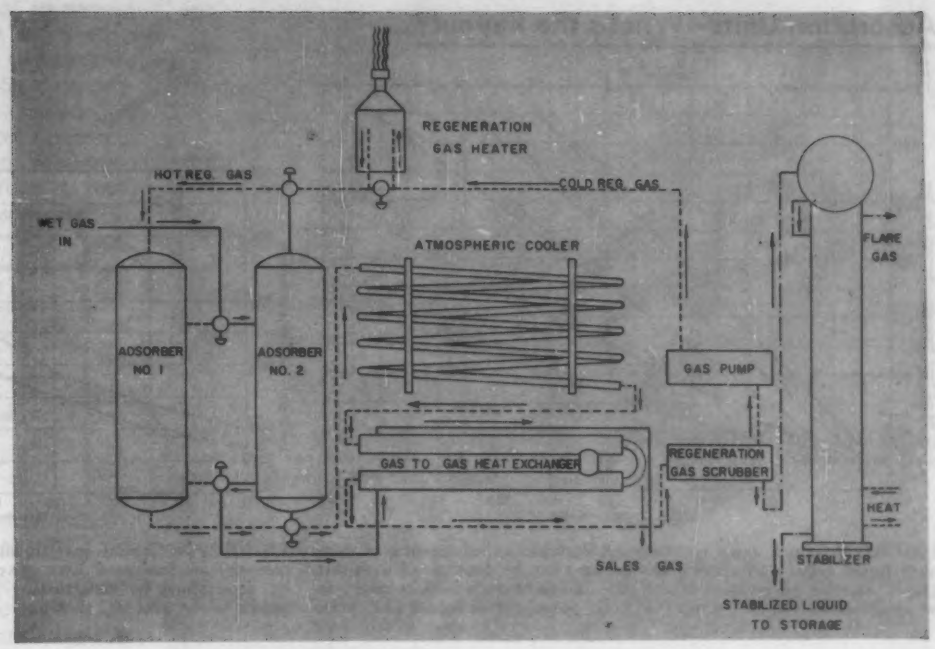


FIGURE 1—This typical adsorption unit is designed to recover isopentane and heavier components from an inlet wet gas stream, and dehydrate the gas sufficiently to meet water content specifications of any present day sales gas contract.

Adsorption Units—What's the Payout?

This cost study of gas liquids recovery shows the effect of gas charge and liquid recovery on investment and payout

Fred H. Plitt
Southwest Gas Producing Co., Inc., Monroe, La.

ADSORPTION by short-cycle units is rapidly becoming an important method for recovery of hydrocarbon liquids from natural gas. This study shows that the process is generally economic, yielding a satisfactory payout. Lean gas streams are the most fruitful field for the process, from an economic and availability standpoint. Future adsorption units should be even more economical as a result of the increased interest in the process. Already, manufacturers have improved the extraction efficiency with little increase in cost.

A producer's economic evaluation of an adsorption system should include a complete reservoir study, a determination of expected daily gas deliverability, system pressure and temperature, fractional analysis of the wet gas stream and desired recovery. Such an evaluation will reveal the ultimate yield in dollars returned per dollar invested. The scope of this article is not to show ultimate status, but to indicate the payout period of such equipment at varying conditions of gas content and volume rate. It is hoped, however, that this study will be somewhat of a guide to the operator confronted with producing gaseous streams of this nature at the optimum economic return possible.

Adsorption by solid bed desiccants is an old, well established process. Recently, this dry extraction process also has been applied successfully to the recovery of hydrocarbon components from natural gas. Adsorption is an important addition to the field of gas processing. Greatly improved granular adsorbents, and new thermodynamic and mechanical techniques have advanced the process to a new use—the economic processing of small, lean gas streams. Adaptation of the adsorption process to large lean gas streams

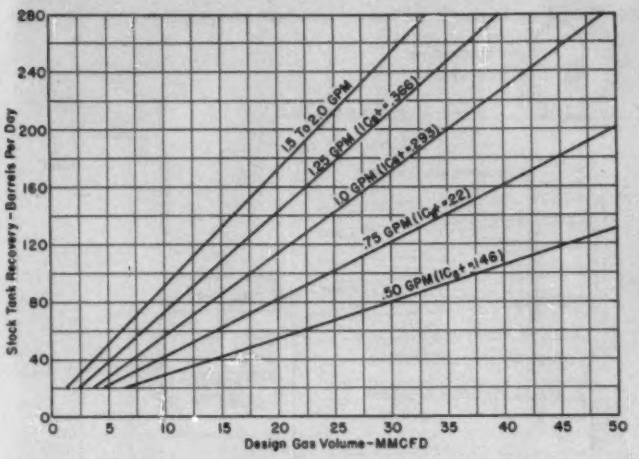

Stock Tank Recovery - Barrels Per Day
Design Gas Volume - MMCFD
1.5 To 2.0 GPM
1.25 GPM (ICg+=.366)
1.0 GPM (ICg+=.293)
.75 GPM (ICg+=.22)
.50 GPM (ICg+=.146)

FIGURE 2—Stock tank recovery attributable to adsorption at constant liquid GPM and varying gas volumes can be determined with this graph. Another observation of this data indicates stock tank recovery to be approximately 6-10 gallons per 1,000 pounds of desiccant per cycle.

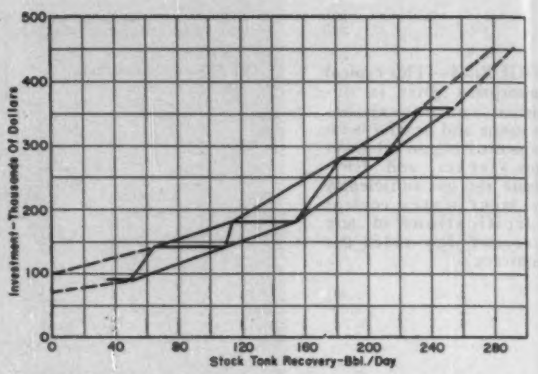


FIGURE 3—Capital investment is a function of product recovery as indicated here. Average investments cost can be determined by constructing a curve through the mid-points of the plateaus shown.

should be economical in many cases; however, at some point the process becomes competitive with the conventional oil absorption process.

Quite early in the history of the short cycle hydrocarbon recovery unit, it was realized that to design for hydrocarbon recovery, three basic steps must be accomplished in as short a time as possible; 1) the adsorbent bed must be saturated to a desired degree, 2) the bed must be regenerated and 3) the bed must be cooled prior to resaturation.

A fourth basic step would involve condensation of adsorbed products from the hot regeneration gas stream.

Liquid recovery is dependent on the number of times a wet gas stream is exposed to a freshly regenerated desiccant bed rather than on the length of exposure time. Excluding other operating variables, a days liquid production is directly proportional to the total number of cycles. In addition to adsorbent properties, adsorption efficiency is influenced primarily by temperature and to a lesser degree by system pressure and incoming gas composition. Equipment manufacturers currently active in this field all have taken into account these physical requirements in the mechanical design of their respective adsorption units. A typical unit as shown in Figure 1 includes the basic equipment used in this economic evaluation.

A typical wet gas stream composition with a propane plus gpm* of 0.750 was taken as a basis for this study. Gas composition was varied based on the ratio of iso-pentane plus gpm to the total gpm of the 0.750 gpm gas. Table 1 shows the fractional analysis of the 0.750 gpm gas stream. Six gas compositions with approximately 30 different gas volume rates were used.

Adsorption towers were considered packed with silica gel and designed to recover in the stock tank 80 percent to 95 percent of the equivalent isopentane plus content of the inlet gas stream. Adsorption equipment was designed for 1,200 psig maximum working pressure, 900 psig operating pressure and 90° F. inlet temperature. Figure 2 indicates stock tank recovery realized through adsorption at constant liquid gpm and varying gas rates.

Capital investment required includes the adsorption unit and all accessories, granular desiccant, a stabilizer, storage tanks, plant site and cost of installation. Figure 3 is a plot of stock tank recovery versus capital investment. As expected, capital investment is a function of product recovery and the range of investment probably is attributable to the normal variation of costs to be expected between one producer and another. Also, note the stairstep increase in investment, with the plateaus being representative of standard equipment sizes available for use over a range of stock tank recoveries. Average investment costs are then revealed by drawing a curve through the mid-point of these plateaus.

TABLE 1—Fractional Analysis—0.750 GPM Inlet Gas Streams

	Mole %	GPM
Methane and Inerts	92.44	.....
Ethane	5.18	.....
Propane	1.23	.339
Iso-Butane	.20	.066
N-Butane	.40	.125
Iso-Pentane	.16	.058
N-Pentane	.10	.035
Hexanes	.16	.065
Heptanes Plus	.13	.062
Total	100.00	0.750

* Gpm defined as gallons of liquid per 1,000 cubic feet of gas.

Figure 4 is a plot using average investment costs to be expected from varying design gas volume rates at a constant gpm content. From this figure, it is indicated that there is little difference in investment costs up to a design gas rate of 10 to 15 MMcfd, regardless of gas composition. From this gas rate upward, however, isopentane plus content of the inlet gas stream becomes a definite factor in equipment size and required investment costs.

Operating costs have been estimated based on the best available industry-wide information. Total operating cost includes direct costs, straight line depreciation charges over 15 years,

simple interest on capital investment over a 5-year period at a 5 percent annual rate and liquid production taxes at the rate of 20 cents per barrel. Table 2 is a sample tabulation of annual total operating costs pertinent to recovery from a 90-bpd adsorption unit. Some of these features, at least, could be considered conservative.

TABLE 2—Annual Operating Expense—90-BPD Unit

Direct Operating Costs	
Labor, Repairs and Supplies	$ 6,500
Overhead	750
Desiccant Change*	5,000
Fuel and Power	4,900
Total Direct Operating Costs	$17,150
Other Costs	
Production Taxes	$ 5,750
Depreciation	8,400
Interest	3,700
Total Other Costs	$17,850
Total Operating Costs	$35,000

* Complete desiccant change annually.

It is generally conceded that desiccant changes will occur annually. However, experience may prove an extended life to be justified. Fuel consumption is more or less fixed as an expense item, while the cost of power will vary with design conditions. Some units regenerate with a split-stream and require no power while other units operate on a closed regeneration system and offer a gas driven regeneration gas pump which also requires no power.

Figure 5 shows two curves and is a plot of stock tank recovery versus operating cost per barrel. The upper curve represents total operating costs and the lower curve represents direct operating costs before production taxes, depreciation and interest. The curves point out the change in operating costs to be expected with changes in adsorption liquid recovery.

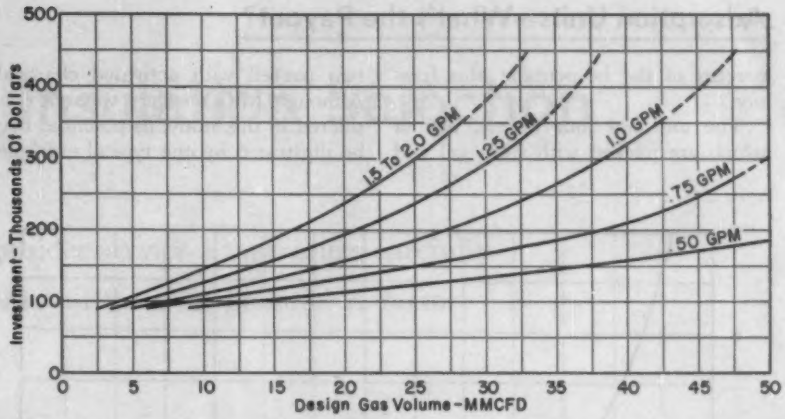


FIGURE 4—It is apparent from this plot that if a 10-15 MMCFD design gas volume is exceeded, the iso-pentane plus content of the wet gas stream becomes a definite factor in equipment size and required investment costs.

Stock tank liquid recovery from an adsorption unit has been assumed to have a gross value of $3 per barrel. Also, it was assumed that the royalty burden would be the normal ⅛ interest. With revenue, liquid production and operating expenses defined, it becomes a simple matter to compute an adsorption system payout.

Figure 6 is a plot showing two curves, each relating capital investment payout to stock tank liquid recovery. These curves show the change in payout at varying stock tank recoveries and indicates optimum adsorption unit size to be approximately 135 bpd. Table 3 is a sample calculation of payout based on a 90-bpd recovery unit.

TABLE 3—Payout Period—90-BPD Unit

Annual Revenue—32,800 Bbl. x .875 x $3.00	$ 86,100
Total Operating Costs—See Table 2	35,000
Annual Gross Operating Profit	$ 51,100
Federal Income Tax @ 52%	26,572
Net Operating Profit	$ 24,528
Add Depreciation—See Table 2	8,400
Annual Profit Available to Retire Capital Investment	$ 32,928
Capital Investment	$ 140,000
Payout: Based on Net Revenue—Years	4.25
Payout: Based on Gross Revenue—Years Before Prod. Taxes, Deprec., Interest and F.I.T.	2.03

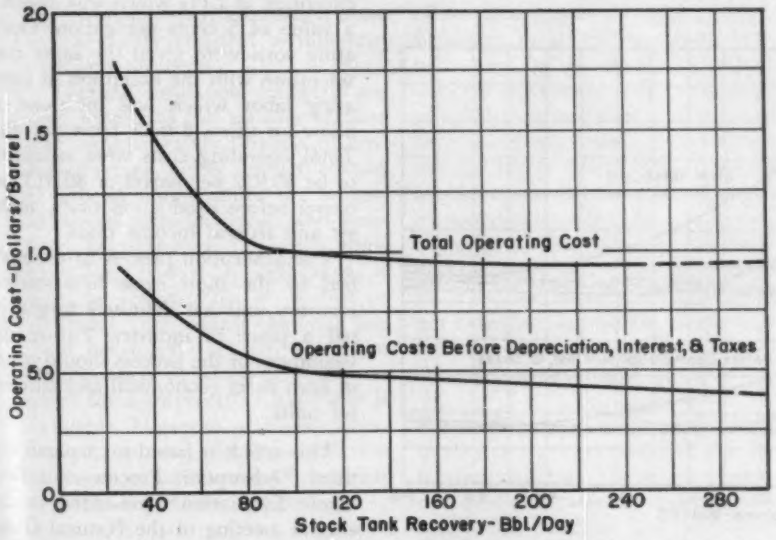


FIGURE 5—These curves show variations in operating costs which can be expected with changes in adsorption unit liquid recovery.

Figure 7 is another presentation of payout at varying design gas rates and at constant gpm content. These curves also depict the optimum design volume for any given gas composition. A more favorable payout than has been indicated by this study can be realized in many cases where dehydration of the gas is a factor. If only the incremental investment over and above conventional dehydration equipment were used, the payout period would be reduced considerably.

Adsorption of LPG. Although adsorption of iso-pentane plus from a wet gas stream is rapidly becoming common place, it should be noted that its greatest potential possibly lies elsewhere—the adsorption of liquefied petroleum gases. At least one unit is available and in operation which is capable of LPG adsorption. This unit now is recovering 43 percent propane, 80-85 percent of the butanes and 100

percent of the iso-pentane plus fraction.

The unit has four towers, two of which are packed with silica gel and two packed with activated charcoal. Although LPG recovery was not considered in this study, its potential may be illustrated by one typical example.

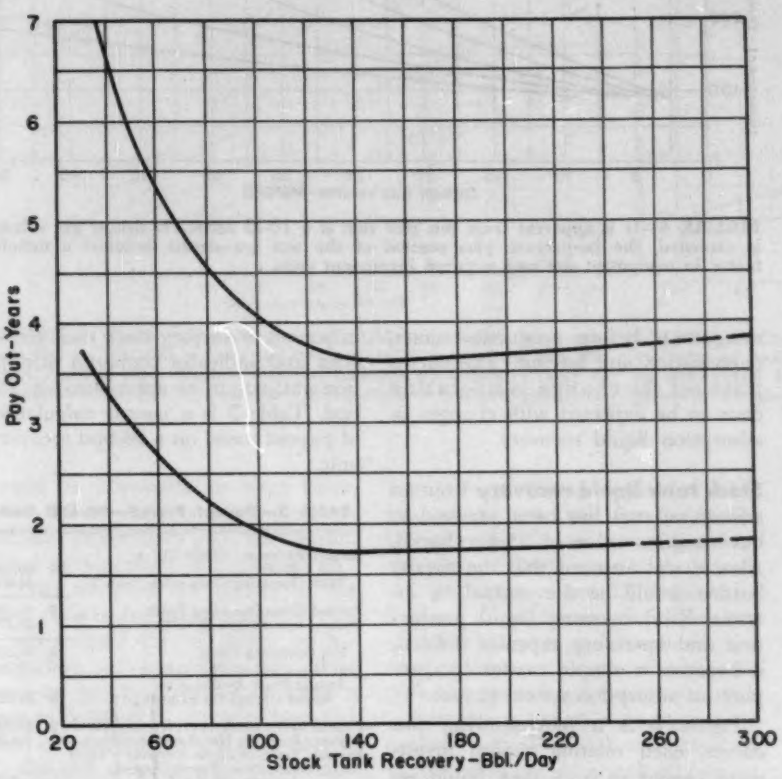


FIGURE 6—Each of these curves relate capital investment payout to adsorption unit liquid recovery. The upper curve indicates payout after total operating costs and federal income tax at 52 percent while the lower curve shows payout before production taxes, depreciation, interest and federal income taxes.

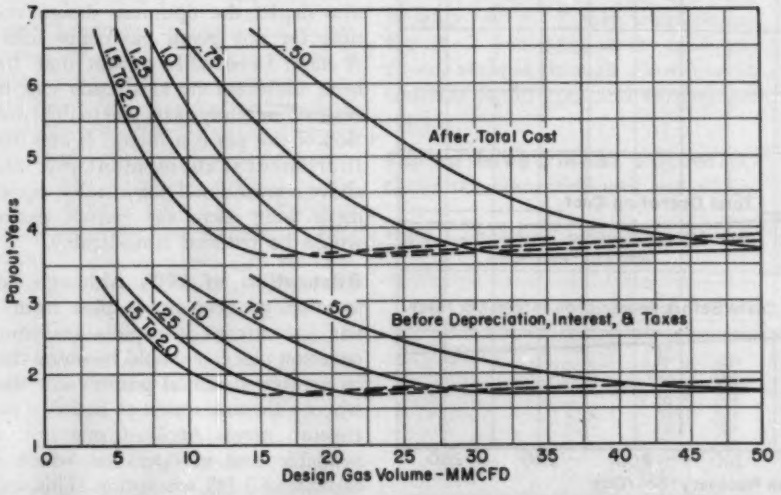


FIGURE 7—Optimum design gas volumes for given gas compositions can be determined from these curves. More immediate payout can be realized if dehydration of the gas is a consideration.

About the Author

Fred H. Plitt received a B.S. degree in chemical engineering from Louisiana Polytechnic Institute in 1949. He was employed by Hunt Oil Company from 1949 until 1953 in gasoline plant operations. From 1953 until 1957 he worked as a production engineer for The Carter Oil Company in the Mid-Continent area. Since 1957, he has served as a staff engineer with Southwest Gas Producing Company, Inc., in Monroe, La.

Assuming a design gas volume of 26.5 MMcfd of a 0.750 gpm gas with the same composition as shown in Table 1, and designed for stock tank recovery of 21 percent of the propane, 80 percent of the butanes and 97 percent of the iso-pentanes plus, indicates a payout after total costs of 3.19 years, or a payout of 1.52 years before production taxes, interest and federal income taxes.

Referring again to Figure 7, it becomes apparent that this is more attractive from a payout standpoint than is the case with only iso-pentane plus recovery. Capital investment for such a unit is estimated to be $250,000. Revenues are based on the same value mentioned previously with the exception of LPG which was assigned a value of 5 cents per gallon. Operating costs were given the same consideration with the exception of operating labor which was increased to allow for three, 8-hour tours per day. Total operating costs were estimated to be $0.932 per barrel or $0.613 per barrel before production taxes, interest and federal income taxes.

The adsorption process as exemplified by the short cycle hydrocarbon recovery unit has definitely forged itself a place in industry. Future development of the process should result in even more economical and successful units.

This article is based on a paper entitled "Adsorption Process—An Economic Evaluation," presented to the annual meeting of the Natural Gasoline Association of America, Dallas, April 22-24, 1959. # #

Shortcuts to Insulation Selection

The first step is to consider service temperature carefully and not rely too heavily on the time-honored K factor

L. L. Leach, Jr.
Humble Oil & Refining Company
Baytown, Texas

THE UNIVERSAL thermal insulant has not been developed; therefore, selection of insulating material should be based on a number of factors, the most important being service temperature. Furthermore, all modern, commercial insulants have acceptable conductance factors ("k" values) and although conductance must be considered, this one characteristic should not weigh too heavily in making the material selection. The aids included with this discussion have been prepared to assist the insulation designer, but are not intended to replace calculations in cases where temperature control is a critical consideration. However, these aids will be sufficiently accurate for most applications. Finally, the use of aluminum in process equipment and in insulation is gaining favor, but each installation must be carefully designed to minimize corrosion problems.

Thermal insulation materials are used to reduce the transfer of heat and concurrently provide an economic return, either through control of process temperatures or through improved personnel safety and comfort. Even though insulation finds extensive industrial application, it must be realized that no perfect or universal insulating material has been developed—actually there are few instances in which an ideal material for a particular problem is available. However, after consideration of a number of factors, selection of the most satisfactory insulant for a particular job can be made.

Service Temperature. Of the many ways to categorize insulation materials and insulation problems, a grouping based on service temperatures offers one of the clearest means of separation because this condition dictates the basic insulating substance and the required exterior finish. These groupings are high, low, and medium, or atmospheric temperature service. After placing the problem into one of these broad classifications, consideration must then be given to several physical characteristics of the insulating material. Each of these factors will have some bearing on the ultimate satisfaction and economy derived from the insulation, and therefore, they should be given due thought before the specifications and procedures are written.

The efficiency of an insulating material is measured by its thermal conductivity or "k" factor and is one of the first qualities investigated. However, nearly all modern insulants have an acceptable "k" value and the differences between them generally are not sufficient to warrant a selection based too heavily on this one characteristic. The efficiency merely sets broad limits on the field of material selection. Also, it should be noted at this time that the presence of water will cause an increase in "k" value. Since this condition is not desirable, the quality of inherent moisture resistance becomes a concurrent consideration.

Ruggedness. Another important quality is the ruggedness of the insulation material. The selected material should be able to undergo normal rough handling that will occur during shipment, warehousing and local transportation with a minimum of breakage. This characteristic is especially important when reuse of the insulant is likely. Additional characteristics which will have an influence on the final material selection and should be considered are: moisture deterioration, dimensional stability at elevated temperatures, ease of fabrication and handling, vibration resistance, chemical activity and others. However, of the many factors governing the choice of an insulating material, the operating temperature is usually controlling.

Extremes in temperature will create conditions which can be detrimental to the insulating material if proper design precautions are not taken. In particular, the material must be chosen for the service. Low temperatures promote water condensation; therefore, materials which may be affected by water are poor choices for this service. Furthermore, some good insulants suffer deterioration at moderately high temperatures and use above their prescribed limit is to be avoided. The use of 85 percent magnesia, one of the most efficient and widely employed insulating materials, is limited by both of these conditions. This insulant is composed of basic magnesium carbonate reinforced with long asbestos fibers and is occasionally contaminated with hydroxides and chlorides. When this material becomes moist, some of the impurities dissolve and form a very good electrolyte which, in turn, promotes corrosion of the equipment insulated. Therefore, this insulant is unsatisfactory for low temperature service. Above 600 F., 85 percent magnesia begins to shrink, crack and generally deteriorate. This

characteristic sets the upper temperature limit of the material. This discussion is not intended to detract from the usefulness of 85 percent magnesia as an insulant. It is offered to point out the necessity of giving the operating temperature preliminary consideration when choosing an insulating material.

Low Temperature. The distinguishing features of a good low temperature insulating material are its very low rate of water absorption and complete inertness toward water reactions. Natural cork and manufactured silica products such as mineral wool, glass fibers and cellular glass are the insulants most nearly filling this specification. Cork, being an organic material, will char at fairly low temperatures; therefore, its use above 200 F. is not recommended. The upper temperature limits for the silica insulations are usually determined by either the resin binder used or the fusing point of the material.

High temperature insulation requires an entirely different approach than low temperature problems because neither vapor nor condensate is usually of concern. In these cases, maximum anticipated temperature is the governing factor. If the temperature is to be below 600 F., 85 percent magnesia is usually the best choice because it is considered to be the most efficient high temperature insulant and has other attractive properties such as being easily fabricated and nonirritating to personnel. However, if the maximum temperature is to be above 600 F., the equipment may be insulated by having a layer of higher temperature silica base insulating material adjacent to the pipe and thick enough to reduce the temperature to the 600 F. limit, followed by an outer course of 85 percent magnesia for further conservation of heat.

In the case of long pipe lines which operate at elevated temperatures, it is often necessary to use two layers of insulation to protect the line from developing uninsulated areas during operation. These bare areas are caused by expansion of the pipe while at the same time most insulation is subjected to shrinkage. By using two layers of insulation and staggering the joints, it is possible to keep the pipe covered with insulation and to eliminate these bare spots. This procedure is expensive insofar as labor costs are concerned, and at pilot units with short pipe runs it has often been found more economical to use only one heavy layer of the less efficient, but competitive in price, silica base insulating material instead of magnesia. Furthermore, since warehousing is expensive, many refineries choose to maintain no stock of 85 percent magnesia, but to fill all high temperature insulation needs from a supply of silica type high temperature insulating material.

Medium Temperatures. Of the three general classes of insulation problems, that of insulating for medium temperatures is most neglected. The temperature limits on the insulating material are easily met, but the problems of moisture and of maintaining a constant temperature for process reasons become most difficult. Since the conductivity factor "k" used in design calculations is determined with the material dry in accordance with ASTM Standard C 177-45, some correction should be made for a change in conductivity of the insulation in the event of atmospheric water vapor absorption. However, because so many variables must be considered, no generally accepted method for adjusting the "k" factor due to a change in water content of the material has been developed. Since the effect of water cannot be accurately assessed, exact calculations of heat flow through damp insulation cannot be made. Although the assumption used under these circumsances usually give satisfactory answers, it should be noted these are only approximations and may not be valid under all conditions. In addition, the moisture promotes rusting and corrosion of the equipment as well as deterioration of the insulation. Since all of these difficulties occur only when water is present, the obvious solution is to eliminate the source of trouble. Where possible, water elimination is carried out by first allowing the insulation to dry as thoroughly as possible after application, and after which the surface is covered with a nonporous membrane such as cutback asphalt. This membrane is designed to prevent the migration of air and its accompanying water vapor, which, in turn, will minimize the amount of water available for damage.

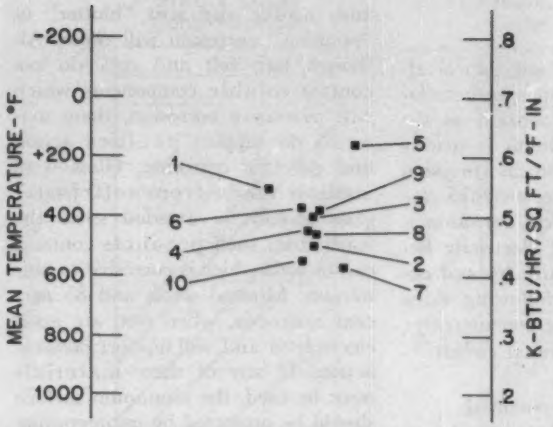
Application. Table 1 lists various generic types of insulating base material and their temperature limits. Figure 1 is a nomograph giving the "k" value versus mean temperatures of several of these insulating materials. In preparing this nomograph, the "k" values were assumed to have a linear relation with temperature. Application of this nomograph should be limited to the temperature limits of the insulating material under consideration. Figure 2 gives the heat loss per lineal foot of pipe covered with 2 inches of hydrous calcium silicate and asbestos insulation. Conversion factors are included to convert to 1 inch or 4 inches of insulation. If material other than hydrous calcium silicate and asbestos is under consideration, it will be necessary to determine the heat loss as

TABLE 1—Insulating Materials

Description of Material	Temperature Limits
Natural Cork	—300 to 200 F
Mineral Wool	—300 to 1,800 F
Glass Fibers	—120 to 400 F
Cellular Glass	—450 to 800 F
Laminated Asbestos Paper	100 to 700 F
Fibrous Asbestos (Amosite)	100 to 1,200 F
85% Magnesia	100 to 600 F
Hydrous Calcium Silicate and Asbestos	100 to 1,800 F
Diatomaceous Silicas and Asbestos Fibers	100 to 1,600 F
Calcined Diatomaceous Earth, Asbestos and Binder	100 to 1,800 F

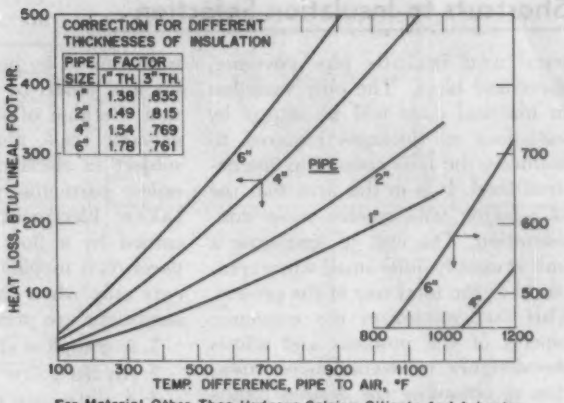
Insulation Trade Names Classified for Readers

Table 1 has been expanded to include insulation manufacturers with the trade names of their products. To obtain a copy of this table, which will help you to classify these products quickly, circle E 23 on green card, last page of this issue.



1. Cellular Glass
2. Mineral Wool 300-600 F
3. Hydrous Calcium Silicate And Asbestos Fibers - Brand A
4. Hydrous Calcium Silicate And Asbestos Fibers - Brand B
5. Calcined Diatomaceous Earth, Asbestos And Binder
6. High Temp. Hydrous Calcium Silicate And Asbestos Fibers
7. Natural Cork
8. 85% Magnesia
9. Asbestos Sponge
10. Glass Fibers

FIGURE 1—K values vs. mean temperature (left). The K values were assumed to have a linear relationship with temperature.



For Material Other Than Hydrous Calcium Silicate And Asbestos Fibers, Determine Ratio Of "K" Factors From Table I And Apply To Values Found From These Curves

FIGURE 2—Heat loss vs. temperature difference using two-inch hydrous calcium silicate and asbestos fiber insulation.

if hydrous calcium silicate and asbestos were the insulant and then multiply by a ratio of "k" values determined from Figure 1.

Figures 1 and 2 may be used in the following manner:

PROBLEM: Pipe Size = 4 inches.
Metal Temp. = 468 F.
Air Temp. = 78 F.
Insulation Specs. = 1 inch thick layer of 85 percent Mag.

How much heat should be returned to the pipe to assure no change of temperature?

SOLUTION:

1. Temperature differences = 390 F.
2. From Figure 2—Heat Loss = 134 Btu/lin. ft./hr.
3. Correction for 1 inch insulation = (134) (1.54) = 206 Btu/lin. ft./hr. loss
4. Mean temperature: $\frac{468 + 78}{2}$ = 273 F.
5. From Figure 1: k_{273} for 85 percent Mag. = .395
   k_{273} for hydrous calcium silicate and asbestos = .445
6. $\left(\frac{.395}{.445}\right)$ (206) = 183 But/ft./hr. loss

Therefore, 183 Btu/ft./hr. should be returned to the pipe to compensate for the heat losses under these conditions. Classical calculations show the heat loss to be 189 Btu/lin. ft./hr. Although these curves are not entirely accurate because of simplifying assumptions, the error resulting from their use will seldom exceed 5 percent of the values. Where differences of this magnitude are significant, formal calculations should be made.

The final success of an insulation installation depends almost entirely on how well the exterior surface protects the base material from water and water vapor. In the case of low temperature, the exterior finish must provide a vapor barrier to prevent vapor migration toward the equipment. In the case of a high temperature installation, the exterior finish must be porous to allow egress of water vapor. In the case of atmospheric temperature problems, the exterior finish must be impervious to surface water as well as vapor pressure from either side.

Vapor Seal. On insulation projects where temperatures below 32 F. are found, water and water vapor impose a considerable problem. Where a route for air occurs, such as at a break in the insulation, water is found in all three states; vapor, liquid and solid. Such a condition is particularly objectionable because it destroys the insulation in two ways. The water, being continually present, is likely to damage the insulation permanently; and the ice formation on the pipe will continue to grow and, in doing so, create sufficient force to break the insulation away from the pipe. An impervious vapor seal is, therefore, extremely important to a low temperature insulation installation. One of the best such seals is a prepared mixture of asbestos fibers and asphalt. This seal is manufactured to be sprayed, brushed or troweled onto the surface. After application, the material dries to a tough, plastic, nonporous film that is not soluble in water and will not allow the migration of water or water vapor across it.

High temperature insulation presents an entirely different problem. In this case, it is necessary to allow the escape of steam formed behind the exterior surface, but at the same time prevent the entrance of rain and other surface water. In other words, there should be a moisture barrier, but no vapor barrier. This is accomplished by using a porous, emulsified asphalt membrane over the insulation and protecting the installation with a finish coat of fireproofed roofing paper.

Material and Labor Costs. In addition to these considerations, it is necessary to weigh the cost of material and labor required before an insulation project can be specified or completely planned. Figure 3 is based on quotations received from contractors in January, 1955, for a large insulation contract. These data are included to show relative costs only and should not be escalated directly. The costs shown are for labor only; material costs are given in Table 2. It is to be noted that these material prices are identical for any commercial, high temperature insulation ma-

terial and include pipe covering, sheet and block. The only variation in material costs will be caused by variations in thickness required to maintain the heat content at the desired level. It is in this area that the "k" factor will receive most consideration. The cost of insulating a unit is usually quite small when compared to the total cost of the project. This fact minimizes the economic aspects of the problem and allows the designer to devote more attention to obtaining the desired results from the insulation.

Aluminum Insulation. The use of aluminum as an insulant and for process equipment is increasing and merits some discussion. The acceptance of aluminum has lagged considerably because of unfortunate corrosion experiences encountered by aluminum users beginning in 1946 when the aluminum shortage began to ease. Some of these experiences were caused by poor selection of alloy and others by improper installation. Because of its position on the galvanic scale, aluminum is readily subject to electrochemical corrosion unless particular precautions are taken. Electrochemical corrosion is caused by a flow of electricity between two metallic surfaces and occurs only when the following three conditions are present concurrently:

1. A complete electrical circuit
2. An electrolyte
3. A difference in potential.

In addition to this type of corrosion, contact between aluminum and nonmetallic materials may cause metal corrosion. For instance, paper or cloth may contain water-soluble chemicals which are corrosive, and even if the particular non-metal is not corrosive, it may hold moisture against the metal for prolonged periods. This latter condition can result in an oxygen starved anode and, under the wet "blotter" or "poultice," corrosion will occur. Although hair felt and cork do not contain soluble components which will promote corrosion, these materials do support poultice action and galvanic corrosion. Glass wool insulants made from soft (soda) glass should be avoided since the leach from such products contains caustic soda which is corrosive to aluminum. Mineral wools and 85 percent magnesia, when wet, are good electrolytes and will support galvanic action. If any of these materials must be used, the aluminum surface should be protected by impregnating the insulation with an inhibitor, properly priming the aluminum surface, and using a moisture barrier. Thermal insulating materials which do not cause serious attack on aluminum are the borosilicate glass wools and foams, aluminum foil, certain calcium silicate base insulations, and some impregnated felt insulants. Particular precautions must be taken when aluminum is in contact with another metal, or when in contact with an electrolyte which, in turn, is in contact with another metal. When these conditions occur, provision should be made to control corrosion by coating, inhibiting, using cathodic protection, or using electrical insulation. The difficulty in isolating aluminum from other metals in the system has been one of the strongest deterrents to the extensive use of the metal for process equipment, insulation or jacketing.

Aluminum jacketing of lines for weather protection is gaining in favor although its use is confined to certain specialized applications. In an internally circulated report prepared by Humble's Enginering Division during 1949, it was stated that equal payout would be realized if the aluminum jacket had a service life of 13½ years compared to 10 years for roofing felt. In 1956, the installation of aluminum jacketing was concluded to be economical if the piping had an expected life in excess of 10 years. Since these two reports agree rather closely, it is concluded that under certain conditions and on permanently installed lines, aluminum jacketing is economical. However, if a use life of the line of 10 years or less is anticipated, or if other, stronger reasons indicate, the advisability of using indicate advisability of using alumi-

TABLE 2—List Prices—All High Temperature Pipe Coverings and Blocks*

The following list prices are to be used for pricing all pipe coverings of corresponding thickness, except that 1" thick list prices are to be used for pricing all pipe coverings of 1" or less thickness.

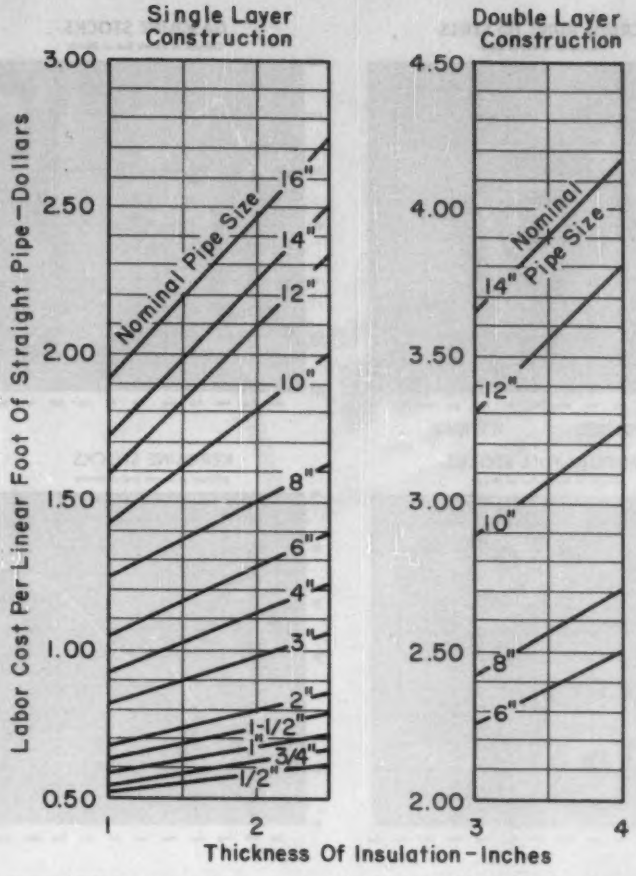
Nominal Pipe Sizes	1 Inch Thick	2 Inch Thickness	3 Inch Thickness	4 Inch Thickness	5 Inch Thickness	6 Inch Thickness
Inches	Price per Lineal Foot	Price per Lineal Foot	Price per Lineal Foot	Price per Lineal Foot	Price per Lineal Foot	Price per Lineal Foot
½	$0.22	$0.75	$1.20	$1.95	$2.90	$4.05
¾	.24	.80	1.35	2.15	3.10	4.20
1	.27	.85	1.40	2.20	3.15	4.25
1¼	.30	.90	1.45	2.35	3.45	4.45
1½	.33	.95	1.55	2.40	3.50	4.65
2	.36	1.00	1.65	2.45	3.60	4.75
2½	.40	1.05	1.75	2.70	3.90	5.10
3	.45	1.15	1.90	2.85	4.00	5.25
3½	.50	1.25	2.05	3.15	4.35	5.65
4	.60	1.35	2.20	3.30	4.45	5.75
4½	.65	1.45	2.35	3.50	4.80	6.20
5	.70	1.55	2.50	3.55	4.85	6.25
6	.80	1.70	2.70	3.90	5.30	6.70
7	1.00	1.85	2.90	4.25	5.75	7.35
8	1.10	2.00	3.15	4.55	6.10	7.85
9	1.20	2.20	3.40	4.90	6.65	8.35
10	1.30	2.40	3.65	5.40	7.10	9.00
11	1.75	2.55	3.90	5.70	7.50	9.50
12	1.85	2.70	4.10	6.00	7.90	9.90
14	2.10	3.00	4.60	6.50	8.55	10.60
15	2.25	3.15	4.85	6.85	8.95	11.10
16	2.35	3.30	5.10	7.15	9.30	11.60
17	2.50	3.45	5.35	7.50	9.70	12.05
18	2.60	3.60	5.60	7.80	10.10	12.50
19	2.75	3.80	5.80	8.10	10.55	13.00
20	2.85	4.00	6.00	8.45	10.85	13.50
21	3.00	4.15	6.25	8.75	11.25	13.90
22	3.10	4.30	6.50	9.05	11.65	14.45
23	3.20	4.40	6.75	9.35	12.05	15.00
24	3.30	4.50	7.00	9.65	12.45	15.35
26	3.55	4.85	7.50	10.35	13.25	16.40
27	3.65	5.05	7.70	10.60	13.65	16.65
28	3.75	5.15	7.95	11.05	14.05	17.15
30	4.00	5.50	8.40	11.55	14.70	17.95
32	4.30	5.90	9.10	12.10	15.45	19.00
33	4.40	6.05	9.20	12.45	15.75	19.25

ALL HIGH TEMPERATURE SHEETS AND BLOCKS

The following list prices are to be used for pricing all sheets and blocks of corresponding thickness.

Thickness	Price Sq. Ft.	Thickness	Price Sq. Ft.
1 inch	$0.30	2½ inch	$0.75
1¼ inch	.38	2¾ inch	.83
1½ inch	.45	3 inch	.90
1¾ inch	.53	3½ inch	1.05
2 inch	.60	4 inch	1.20
2¼ inch	.68	4½ inch	1.35

* Note these list prices were established several years ago by all of the manufacturers. The present *selling* price is approximately list price *plus* 25 percent.



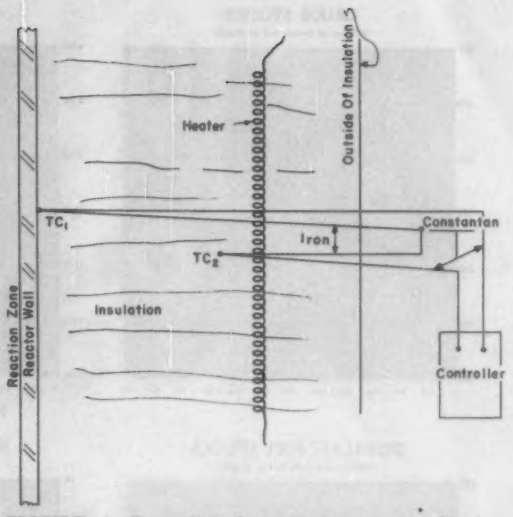


FIGURE 4—For adiabatic operations, use a heating element to maintain a minimum temperature difference.

FIGURE 3—Insulation labor costs based on actual bids for a particular job. The graphs (left) are based on prices quoted by contractors in January, 1955 for a job in the Humble Oil & Refining Co., Baytown, Texas refinery. The insulation specifications called for moulded type insulation using 15-50 lb. paper with bands over the covering at nine inches on center. The paper was lapped but not sealed and no finish vapor seal was specified. The work consisted almost entirely of overhead insulation (above six feet). The cost data presented in this figure applies only to the job as specified. Other specifications and other job locations will certainly affect the labor costs.

num jacketing is to be questioned.

Adiabatic operations are often of primary interest in developmental work and the success of those operations depends to a considerable extent on the efficiency of the insulation. Since there is no perfect thermal insulator, efforts toward attaining adiabatic operation include insulation and supplementary heat. A commonly used installation for adiabatic operation is shown in Figure 4. Since heat flow is in the direction of the cold body, adiabatic operation is approached by maintaining a minimum temperature difference between TC_1 and TC_2 through use of the resistance heater imbedded in the insulation. It is reported that 90-95 percent approach to adiabatic operation can be obtained by this method. The major difficulty encountered in adiabatic operations stems from the lag between a change in temperature at TC_1 and the time required for the temperature at TC_2 to be brought to the new condition.

Although the choice of materials is important to the satisfaction derived from an insulation installation, the skill and craftmanship of the applicator are equally important. Improper installation can result in failure of the best material; and likewise, proper and careful installation of poorly chosen material can often result in an entirely satisfactory insulation installation. For these reasons, it is important that the applicator appreciate the value of his contribution.

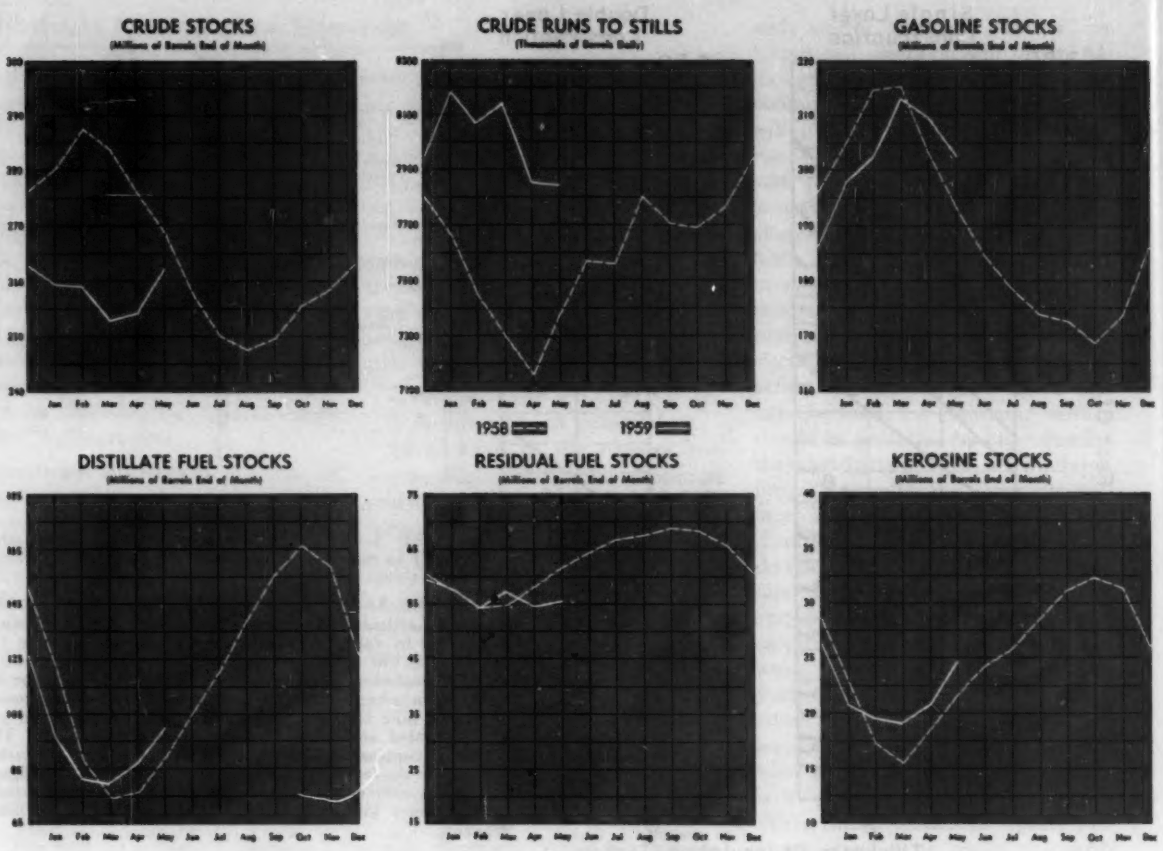
The author wishes to acknowledge the use of unpublished material from the personal files of Mr. Rubin E. Kappler of the Technical Division of Humble Oil and Refining Company. In addition, various manufacturers and their representatives have rendered considerable assistance toward the preparation of this paper.

BIBLIOGRAPHY

Salisbury, J. K., Ed., *Kent's Mechanical Engineer's Handbook, Power Volume*, New York, Wiley, 1950
McDannald, A. H., Ed., *The Encyclopedia Americana*, New York, Americana Corp., 1946
Rockwell, T. F., Chairman, *Heating, Ventilating, Air Conditioning Guide*, 1947, New York, Amer. Soc. of Heating & Ventilating Engineers.
Thomas Ray, "Thermal Insulation for Industrial Requirements," *Petroleum Refiner*, Jan., Feb., Mar., June, July, Aug., Oct., Nov. 1952, Jan., Feb., 1953
Canon, Ron, "Low Temperature Insulation," *Petroleum Processing*, June 1957
Swain, P. and Hicks, T., "Power's Handbook on Heat Insulation," *Power*, Various Issues 1949 through 1952
Armstrong, Don, "Fundamentals of Industrial Insulation" The Aber Co., Houston, 1958

About the Author

L. L. Leach, Jr., is a senior research mechanical engineer for Humble Oil & Refining Co., Baytown, Texas, where he provides mechanical engineering consulting service to the research and development staff. He is also a project engineer for capital expenditure projects of research and development, and has design responsibility for pilot units and equipment. A graduate of the U. S. Merchant Marine Academy and Louisiana State University with a B.S. degree in mechanical engineering, Leach is a registered professional engineer in Texas. He has experience as a marine engineer, cycling plant mechanic and operator, metal and equipment inspector, and M & C planner.



Taking Stock

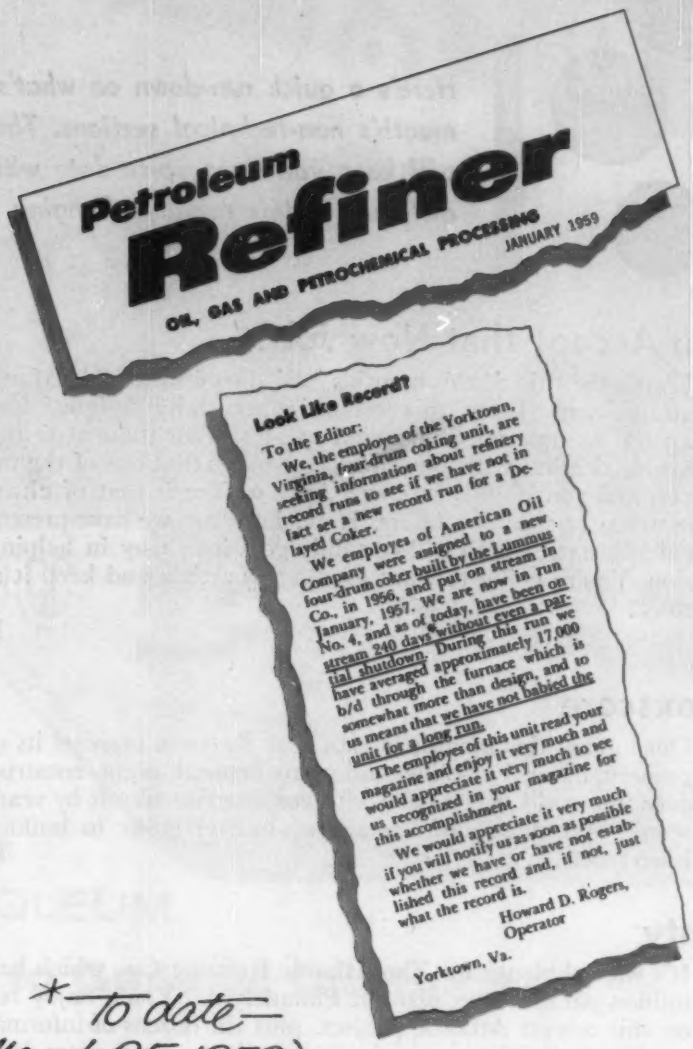
- Crude stocks up sharply
- Runs to stills leveling off
- All other stocks following seasonal trends

U.S. Petroleum Demand and Supply (Thous. Bbls. Daily)

ITEM	May 1959	May 1958	% Diff.	Apr. 1959	January-May 1959	January-May 1958	% Diff.
DEMAND							
All Oils, Total Demand	8,651	8,302	+ 4.2	9,092	9,923	9,401	+ 5.6
Domestic Demand	8,406	8,023	+ 4.8	8,857	9,678	9,133	+ 6.0
Export Demand	245	279	—12.2	235	245	268	— 8.6
Gasoline, Total Demand	4,157	4,106	+ 1.2	4,076	3,902	3,748	+ 4.1
Distillate, Total Demand	1,337	1,253	+ 6.7	1,660	2,194	2,117	+ 3.6
Kerosine, Total Demand	132	143	— 7.7	188	342	370	— 7.6
Residual, Total Demand	1,384	1,236	+12.0	1,511	1,829	1,529	+19.6
CHANGE IN STOCKS							
All Oils, Change in Stocks	—865	—183	....	—223	— 20	—487	....
NEW SUPPLY							
Total New Supply	9,516	8,485	+12.2	9,315	9,943	8,914	+11.5
Domestic Production, Total	8,033	6,980	+15.1	7,991	8,053	7,276	+10.7
Crude Oil	7,183	6,233	+15.2	7,126	7,183	6,489	+10.7
Natural Gas Liquids	850	747	+13.8	865	870	787	+ 0.5
Imports, Total	1,483	1,556	— 4.7	1,324	1,889	1,638	+15.3
Refined Products	559	571	— 2.1	565	978	703	+39.1
Crude Oil, Total	924	935	— 1.2	759	912	935	— 2.5
Crude, East Coast	754	752	+ 0.3	579	721	776	— 7.1
CRUDE RUNS							
Crude Runs to Stills	7,843	7,411	+ 5.8	7,863	8,054	7,430	+ 8.4
Domestic Crude	6,947	6,489	+ 7.1	6,933	7,118	6,517	+ 9.2
Foreign Crude	896	922	— 2.8	930	936	913	+ 2.5

U.S. Stocks of Oils (Million Bbls. at End of Month)

KIND OF OIL	TOTAL IN U.S. May 1959	TOTAL IN U.S. May 1958	TOTAL IN U.S. % Diff.	TOTAL IN U.S. Apr. 1959	EAST OF CALIFORNIA May 1959	EAST OF CALIFORNIA May 1958	EAST OF CALIFORNIA % Diff.	EAST OF CALIFORNIA Apr. 1959
All Oils	786.3	767.8	+ 2.4	759.5	....	....	....	.....
Crude Oil	262.4	263.1	— 0.3	254.2	226.7	219.4	+ 3.3	216.2
Gasoline	203.3	195.2	+ 4.1	209.6	174.1	168.1	+ 3.6	180.1
Distillate Fuel Oil	99.6	89.2	+11.6	85.6	90.1	76.7	+17.5	74.7
Kerosine	24.7	21.4	+15.5	21.1	24.0	21.1	+13.7	20.6
Residual Fuel Oil	55.1	61.6	—10.6	54.5	28.5	29.8	— 4.4	27.5
Other Oils	141.2	137.3	+ 2.8	134.5	.....	.....	.....	.....


Petroleum
Refiner
OIL, GAS AND PETROCHEMICAL PROCESSING
JANUARY 1959
Look Like Record?
To the Editor:
We, the employes of the Yorktown, Virginia, four-drum coking unit, are seeking information about refinery record runs to see if we have not in fact set a new record run for a Delayed Coker.
We employes of American Oil Company were assigned to a new four-drum coker built by the Lummus Co., in 1956, and put on stream in January, 1957. We are now in run No. 4, and as of today, have been on stream 240 days without even a partial shutdown. During this run we have averaged approximately 17,000 b/d through the furnace which is somewhat more than design, and to us means that we have not babied the unit for a long run.
The employes of this unit read your magazine and enjoy it very much and would appreciate it very much to see us recognized in your magazine for this accomplishment.
We would appreciate it very much if you will notify us as soon as possible whether we have or have not established this record and, if not, just what the record is.
Howard D. Rogers,
Operator
Yorktown, Va.

*to date
(March 25, 1959)
their record now stands at 354 days..

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY THROUGHOUT THE WORLD

385 MADISON AVENUE, NEW YORK 17, N. Y.

HOUSTON · WASHINGTON, D. C. · MONTREAL · LONDON · PARIS · THE HAGUE · MARACAIBO

For more data on advertised products, use Readers' Service Cards, last page.

Valuable Reading Ahead

Here's a quick run-down on what's presented in this month's non-technical sections. These departments will keep you right up-to-date with what's new and different in this rapidly changing oil industry.

"Should You Accept that New Job?"

That's the title of this month's lead story in PR's "As Management Sees It . . ." As you no doubt know, this section is specifically designed for those persons in managerial or supervisory positions, and also for those aspiring to such positions. This article dealing with job offers recognizes that one of the most important problems you and your family will ever have to face is that of changing jobs or choosing between several job offers. Here, however, we have presented for you a good logical approach which will certainly go a long way in helping you make your decision. You're going to want to clip this article and keep it around for a long time, so . . .

Keep going to page 241.

Another "Boxscore"

Once again this month, PETROLEUM REFINER presents its quarterly compilation of refinery, natural gasoline, and petrochemical plant construction projects from all over the world. Keep pace with construction trends by reading "Construction Boxscore"—the most complete and up-to-date guide to building in the Industry. To learn more . . .

Keep going to page 216.

Wax a' Plenty

It's wax a' plenty for The Atlantic Refining Co., which has completed a new $18-million paraffin wax plant at Philadelphia. You'll enjoy reading the entire details on this newest Atlantic project, plus the dozens of informative "capsule items" on worldwide building activities in the oil, gas, and petrochemical processing industries. It's all there in the "Who's Building" section. Simply . . .

Keep going to page 192.

Where Did They Go?

Ever wonder what's happened to some of your friends and acquaintances in the Industry that you haven't heard from in a long time. It's highly possible that sooner or later you'll read about them in "Men in Industry", a regular PETROLEUM REFINER feature, and a sure-fire method of keeping up with personnel changes. Why not . . .

Keep going to page 277.

When, Where and What?

For an easy-to-read tabulation of what's coming up in the associations and societies that are of most interest to you, PETROLEUM REFINER's "Meetings Calendar" is a "reading must." Important events are slated for the near future, so . . .

Keep going to page 276.

When it comes to Basic Chemicals for PETROLEUM

... come to General Chemical!

There are good basic reasons for making General Chemical your source of supply for basic chemicals. Large-scale production is one. Long experience is another. And there are many more—including consistent high quality and uniformity of product... top-notch technical service... a coast-to-coast network of plants and distribution points... plus efficient follow-through from order to delivery and beyond that to satisfactory performance. That's why—when it comes to basic chemicals—it's wise to come to General Chemical for all these products:

ALKYLATION
Anhydrous Hydrofluoric Acid
Sulfuric Acid

POLYMERIZATION
Fluosulfonic Acid $HO:SO_2F$
Boron Trifluoride
Sulfuric Acid

SULFONATION
Sulfuric Acid
Sulfan® Stabilized Sulfuric Anhydride
Oleum

ISOMERIZATION
Hydrochloric (Muriatic) Acid

DETERGENTS, CLEANERS & BUILDERS
Sodium Metasilicate
Disodium Phosphate
Sodium Sulfate, Anhydrous
Trisodium Phosphate
Tetrasodium Pyrophosphate (TSPP)
Sodium Tripolyphosphate

ACIDIZING
Hydrochloric (Muriatic) Acid
Hydrofluoric Acid
Sodium Bifluoride

MUD CONDITIONING
Sodium Silicate
Disodium Phosphate
Trisodium Phosphate
Tetrasodium Pyrophosphate (TSPP)
Sodium Tripolyphosphate
Pyrites Cinders

GREASE MAKING
Aluminum Sulfate

ACID TREATING
Sulfuric Acid
Sodium Silicate
Other heavy chemicals, catalysts, addition agents, inhibitors and special "tailor-made" chemicals.

Baker & Adamson® Laboratory Reagents

Basic to America's Progress

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

New Books...

Advances in Refining

"Advances in Petroleum Chemistry and Refining, Volume II," edited by John J. McKetta, Jr., and the late Kenneth A. Kobe, continues the fine work started in Volume I (reviewed in PETROLEUM REFINER, August, 1958). Recent developments in petroleum refining and petrochemical operations are summarized by one to three chapters each in five general fields: (1) Economics and Future Trends, (2) Unit Operations and Design, (3) Refining Processes, (4) Petrochemicals and (5) Mechanical Equipment.

This series is especially strong, for it gives the specialist an opportunity to keep up with fields afar from his own. The series certainly has variety; and theory, development and technology are mingled expertly to satisfy both the chemist and the engineer. Emphasis is on the practical side, however.

"Sulfuric Acid Alkylation of Paraffins" continues the alkylation series started in Volume I. Volume I laid the theoretical background and this chapter presents the commercial technology for the process using the pioneer catalyst in this field. The authors say a later volume will contain a chapter discussing HF alkylation technology.

"Coking Petroleum Residues" is timely, since coastal refineries are beginning to seriously consider and install coking units. This chapter is somewhat long, but filled with good material, as is the case for most of the chapters in Volume II.

"Radiation Processing" presents a good review in this field for the lay reader. "Radiation Techniques" is a good companion article discussing radioisotope uses. If you are wondering whether an isotpe has ever been used, you can probably find out from this chapter.

For the petroleum chemist, "Raw Materials . . ." and "Synthetic Detergents . . ." are must reading. The Raw Materials chapter is very general and is a good beginning for more detailed reading by the reader.

The other chapters deal with a variety of subjects, including mechanical design of cat crackers, commercial production of hydrazine, pebble heaters, and trends in lubricants. This series will be a valuable addition to a technical library.—Reviewed by R. E. Payne, The Pace Co., Houston.

(McKetta, J. J., and Kobe, K. A., *Advances in Petroleum Chemistry and Refining, Volume II,* Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 634 pages, $14.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

Accident Control Manual

"Manual for the Application of Statistical Techniques for Use in Accident Control" makes available fast, accurate analytical methods to safety administrators who are neither mathematicians nor statisticians. Separate sections are devoted to industrial accidents, highway accidents, and to methods of evaluating safety programs. Patterned after methods used successfully in industrial product quality control, the techniques are designed to signal any significant change in the accident process, giving the engineer assurance that a new accident cause has appeared.

(OTS, *Manual for the Application of Statistical Techniques for Use in Accident Control (PB151055),* Office of Technical Services, U.S. Department of Commerce, Washington 25, D. C., 73 pages, $2.)

Chem Engineering Text

"An Introduction to Chemical Engineering" is primarily a beginning text for students in chemical engineering and related fields. It presents material that should be mastered before a study of unit operations and thermodynamics is begun. It does not contain chemical engineering theory as such, but rather explains some of the fundamentals on which that theory is based.

(Littlejohn, C. E. and Meenaghan, G. F., *An Introduction to Chemical Engineering,* Reinhold Publishing Co., 430 Park Ave., New York 22, N.Y., 271 pages, $7.80. For sale by Gulf Publishing Co., P.O. Box 2608, Houston 1, Texas, U.S.A.)

Silicones

"Silicones" covers the manufacture, properties and applications of the silicones. It contains case histories of present industrial applications, and many new ones. These include the use of silicones as rubbers, chemicals, resins, fluids, greases, adhesives, sealants, surface coatings, and many others.

(Meals, R. N., and Lewis, F. M., *Silicones,* Reinhold Publishing Co., 430 Park Ave., New York 22, N.Y., 267 pages, $5.95. For sale by Gulf Publishing Co., P.O. Box 2608, Houston 1, Texas, U.S.A.)

Free Book Catalog

For a free copy of our book catalog write to BOOK DEPARTMENT, GULF PUBLISHING COMPANY, P. O. Box 2608, Houston 1, Texas. Often books reviewed here may be purchased from this source.

Research Task Summary

"Annual Research Task Summary," 1959 Edition, issued by the Office of Technical Services, reviews Army research and development projects in the major fields of science and technology, under way as of September, 1958. The report contains six volumes:

- Volume 1, *Biological, Medical, Social and Behavioral Sciences and Operations Research (PB 151494).*
- Volume 2, *Chemistry (PB 151495).*
- Volume 3, *Physics, Part 1 (PB 151496).*
- Volume 4, *Physics, Part 2, and Mathematics (PB 151497).*
- Volume 5, *Geophysical Sciences and Engineering (PB 151498).*
- Volume 6, *Materials Technologies (PB 151499).*

(OTS, *Annual Research Task Summary, 1959 Edition,* Office of Technical Service, U.S. Department of Commerce, Washington 25, D. C. Price by volumes are, (1) $3.25, (2) $2.00, (3) $3.50, (4) $3.00, (5) $4.75, (6) $2.75.)

NBS Journal of Research

"The Journal of Research" will be published July 1 by the National Bureau of Standards. It will be in four separate sections:

- Section A, *Physics and Chemistry,* issued six times a year.
- Section B, *Mathematics and Mathematical Physics,* issued quarterly.
- Section C, *Engineering and Instrumentation,* issued quarterly.
- Section D, *Radio Propagation,* issued six times a year.

This change is being made to permit more effective dissemination of the Bureau's findings to science and industry. At the same time the editorial scope of the Journal is being broadened to cover the Bureau's technical program as completely as possible.

(NBS, *The Journal of Research,* National Bureau of Standards, Office of Technical Information, Washington 25, D. C. Price by sections are, (A) $4.00, (B) $2.25, (C) $2.25, (D) $4.00.)

Auto Vapor-Lock Factors

"A Correlation of the Factors Which Affect Vapor Lock in Automotive Fuel Systems" (OTS Report PB 131843) is a report of research done for the Army. It discusses the factors influencing vapor lock, i.e., fuel characteristics, climate, and fuel system design. All three contribute to the premature vaporization of fuel which limits the amount of liquid fuel reaching the carburetor and can cause engine misfiring, loss of power, or halt it completely. Tests reviewed in the report show how vapor lock can be eliminated from military vehicles.

(OTS, *A Correlation of the Factors Which Affect Vapor Lock in Automotive Fuel Systems, OTS Report PB 131843,* Office of Technical Services, U.S. Department of Commerce, Washington 25, D. C., 109 pages, $2.50.)

PRACTICAL PROCESS CONTROL

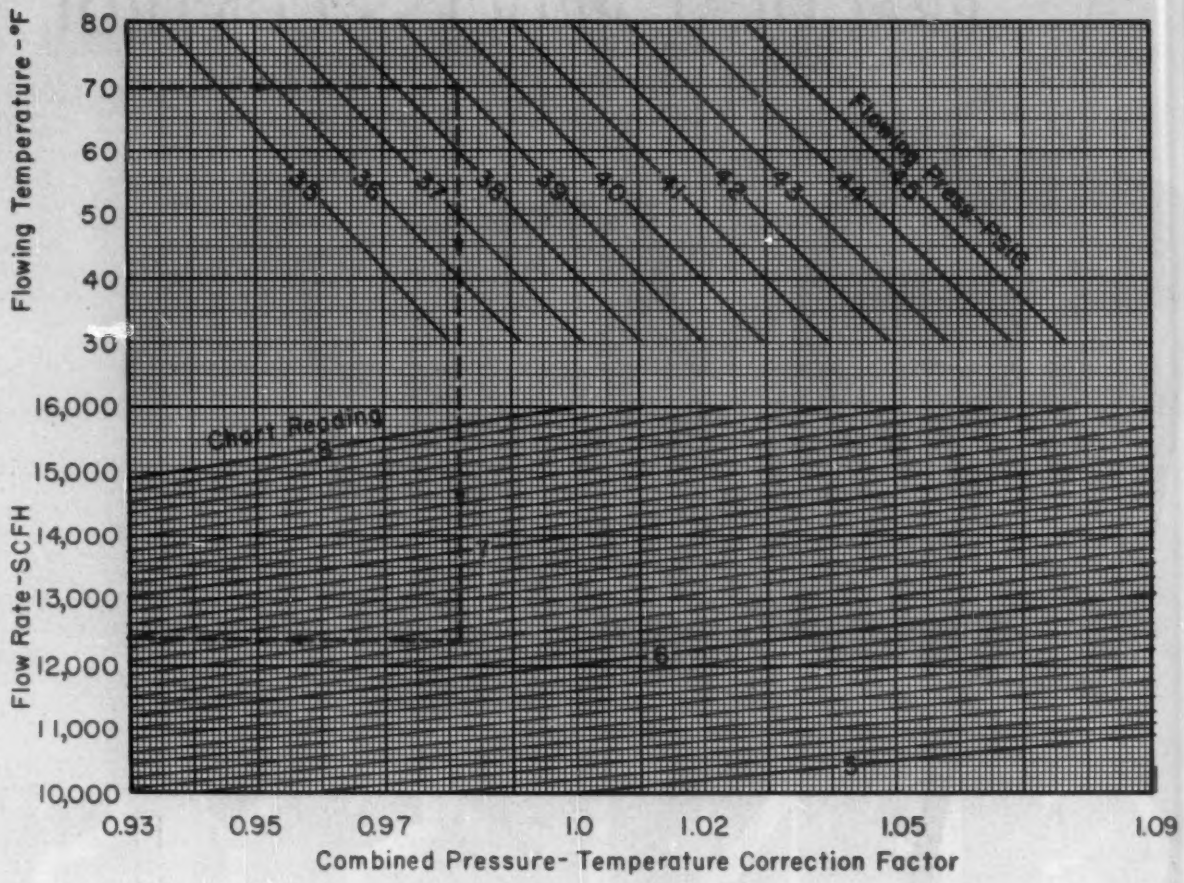
GENESYS

Designed from inception for process control, Genesys advanced digital control computer systems provide many exclusive advantages with unprecedented economy. Knowledge of precise process dynamics is not required. You can *optimize* process operations using your present instrumentation. You get unmatched reliability through practical design, practical computer speed matched to the problem – thus fewer and only the most proven components. Genesys Systems deliver 4,000 hours of continuous, non-stop operation between scheduled maintenance periods . . . dependability with simplicity of operation at low cost . . . seven giant steps forward in process and pipeline automation. Write for "Evolution in Process Control."

Filling the void in practical digital control, this Unit Memory Processor (UMP) is the heart of a Genesys Process Control System, uses the best combination of general purpose and incremental computer techniques.

GENESYS CORPORATION G 10131 NATIONAL BLVD., LOS ANGELES 34, CALIFORNIA

A Subsidiary of CHANCE VOUGHT AIRCRAFT



Use Chart to Correct Gas Flow Rates

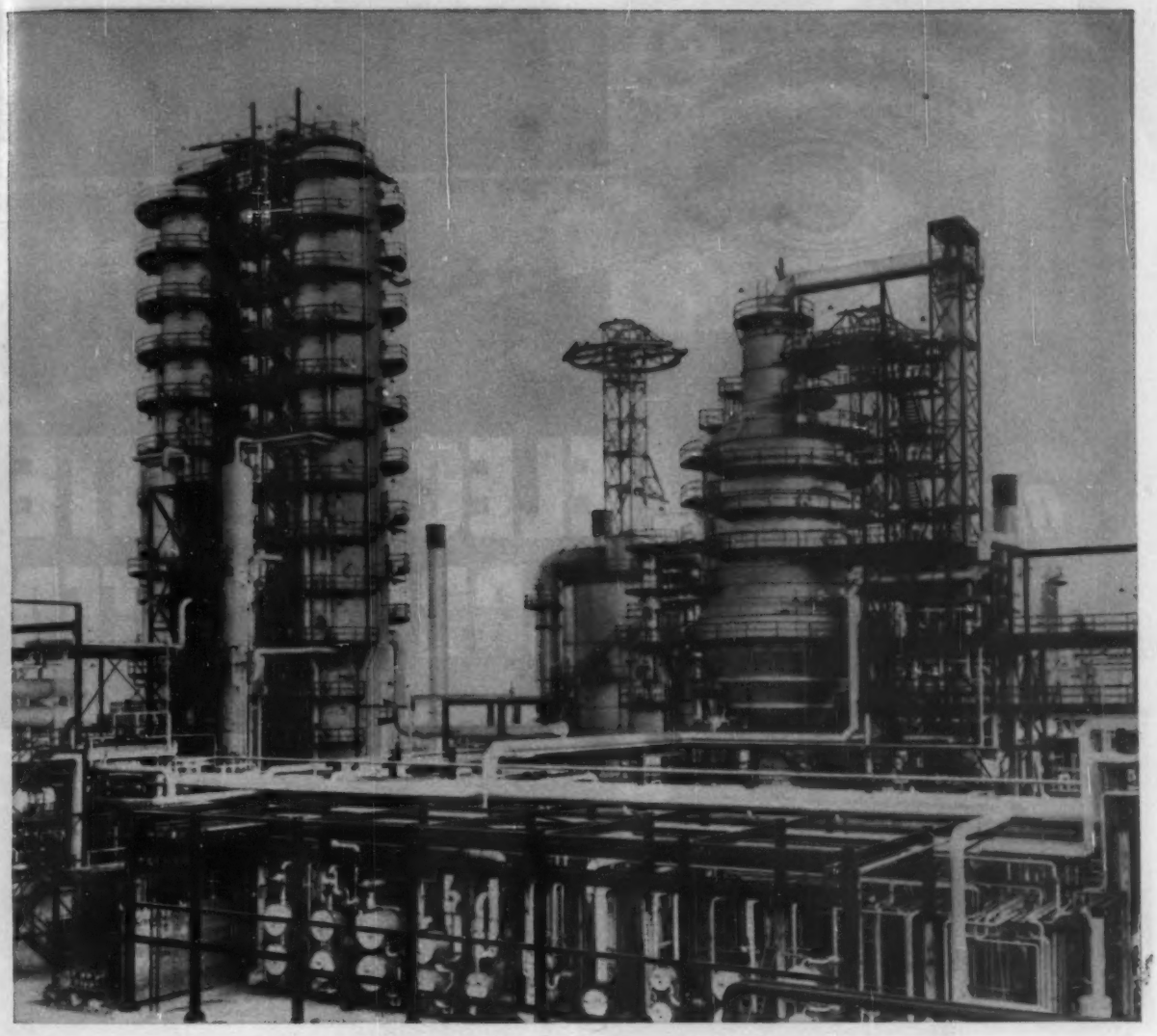
For accurate gas measurements, the flowing pressure and temperature must be considered

The efficient operation of many chemical processes is dependent on accurate control of flow rates of various process streams. In the case of orifice flow measurements of gases, corrections have to be made for flowing conditions of pressure and temperature. For efficient operation of Mississippi Chemical Corp.'s plant, a quick and accurate method was needed for determining gas flow rates which would be corrected for flowing pressure and temperature. To solve this problem, charts which incorporated corrections for pressure and temperature were prepared for gas flow meters in the plant. These charts have aided operators in maintaining an efficient operation. Plant engineers have saved a great amount of time by using these charts in preparing reports on process flows, accounting cost reports, etc.

The method used to prepare these charts, such as shown in Figure 1, is as follows: Standard industrial practice is to use the AGA Report No. 2 for the calculation of orifice sizes for gas measurement. This report gives the formula:

$$Q = F_b \times F_r \times Y \times F_{pb} \times F_{tb} \times F_{tf} \times F_g \times F_{pv} \times \sqrt{h_w P_f}$$

In sizing an orifice, a set of flow conditions of temperature, pressure,



For economical protection from acid condensates, Monel Hortonclad is used in 13 ft diameter vapor top of vacuum column (right) and in upper portions of two 174 ft atmospheric crude columns (left), at the Marcus Hook Refinery of Sinclair Refining Company.

The bigger the tower top, the more it pays to clad it with Monel

The greater the tower top's inside area, the greater the savings by building with Monel* nickel-copper alloy clad materials.

Monel alloy cladding on steel gives lasting resistance to common tower top corrosive condensates. It also resists thermal shock, thermally induced stresses. Monel alloy clad steel is readily formed, welded without special equipment . . . post-weld heat treatment is not required.

In the Marcus Hook Refinery of Sinclair Refining Company (portion shown above), Monel Hortonclad** protects the upper portion of the two 174 ft atmospheric towers at left . . . and the vapor top of the vacuum tower at right. In all three, the use of clad material provides a substantial saving in costs.

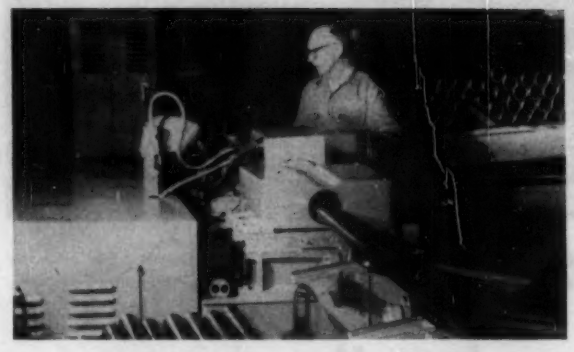
Monel Hortonclad is manufactured and fabricated by the Chicago Bridge and Iron Company. For more information on practical Monel alloy uses in your refinery, write Inco.

*Registered trademark
**T.M. of Chicago Bridge & Iron Company

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y

INCO NICKEL ALLOYS

ONLY REPUBLIC ELECTRUNITE is FARROWTESTED



FARROWTEST®—QUALITY YOU CAN MEASURE. Not a laboratory theory, not a mere inspection tool, but an exclusive production test that detects and rejects tubing containing defects of critical size. FARROWTEST is offered as an alternative to other less positive tests in accordance with table below, at no extra cost.

FARROWTEST REJECT TABLE

Wall Thickness (B.W. Gage)	Minor dimension of the defect (Length or Depth)	Defective Area (Length, Depth Plane)
20	.006"	.0025 sq. inches
18	.006"	.003 sq. inches
16	12½% of wall	.003 sq. inches
14 and 13	12½% of wall	.004 sq. inches
12 and heavier	12½% of wall	.005 sq. inches

FARROWTEST detects and rejects not only tubing containing defects which completely penetrate the wall; but also tubing with defects equal to, or greater than, those shown in this table. For irregular defect shapes, a tube with defect area equal to or greater than shown above is rejectable. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.

QUALITY YOU CAN MEASURE...
ELECTRUNITE HEAT EXCHANGER TUBES
.....CARBON AND STAINLESS STEELS

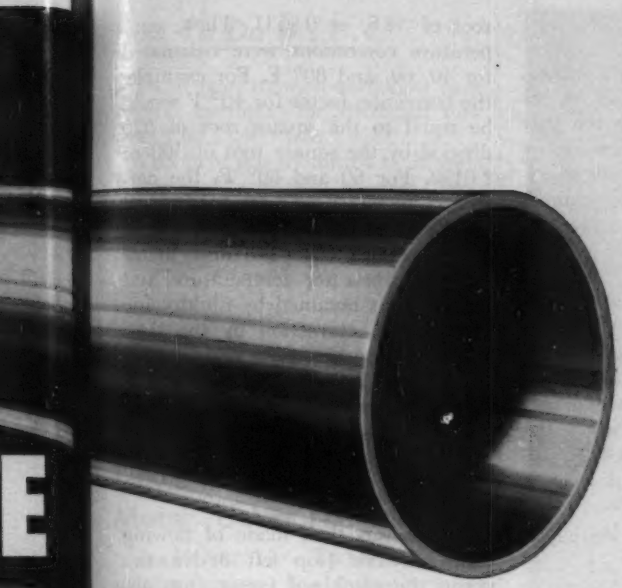
You can get quality you can measure when you specify FARROWTESTED® Republic ELECTRUNITE® Heat Exchanger Tubes.

FARROWTEST is exclusive with Republic. FARROWTESTED tubes must pass the most searching test of all, a non-destructive eddy-current test that probes for and detects injurious defects.

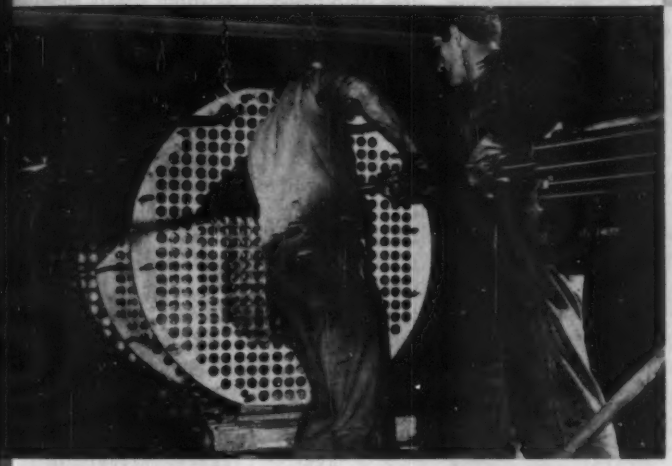
The "magic eye" of FARROWTEST looks deep within the tube wall, is calibrated to reject tube with defects as shown in the table, left. Defects larger than shown in table may pass internal pressure tests, but will not pass FARROWTEST!

FARROWTEST is offered as an alternative to other less positive tests at no increase in cost. Carbon steels produced to ASTM specification A-214; stainless steels to A-249. Both specifications include eddy-current requirements.

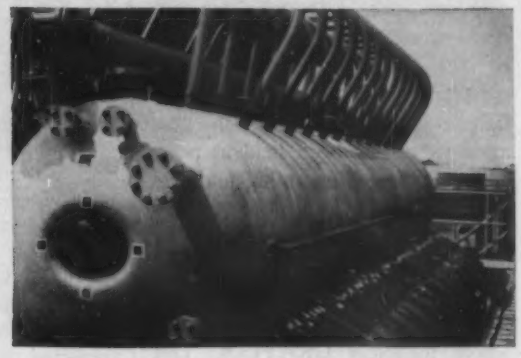
Get *quality you can measure*. Specify Republic ELECTRUNITE Heat Exchanger Tubes—FARROWTESTED for your protection. To get the facts first-hand, call your Republic representative, or write direct.



PROTECT YOUR PRODUCT WITH REPUBLIC STEEL CONTAINERS. Republic's full line of steel containers helps you extend control of product from your shipping floor to point of use. For complete information, send for Republic Containers Catalog. Write today.



REPUBLIC ELECTRUNITE STAINLESS STEEL HEAT EXCHANGER TUBING meets the rigid requirements of critical processing and refining operations. It rolls in easily, resists corrosion, protects the quality of the product. Specify ELECTRUNITE Stainless Tubing for your original and retubing operations. Write today.



REPUBLIC ALLOY STUDS AND HIGH CARBON HEX NUTS solve many problems in the processing industries. They withstand major stress imposed on a wide variety of equipment. Clean accurate threads provide high strength and wear resistance with maximum holding power. Send coupon for latest folders.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. PR-8109
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send information on the following Republic products:

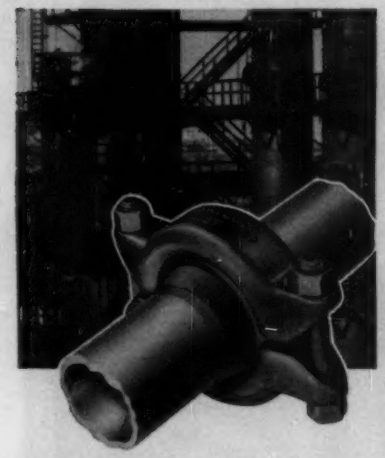
- ☐ Republic ELECTRUNITE Heat Exchanger Tubing
- ☐ Carbon Steels
- ☐ Stainless Steels
- ☐ Containers
- ☐ Republic Alloy Steel Studs

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____



GRAYLOC Connections Hold High Pressures With No Leaks During 197,000 Loading Cycles

GRAYLOC connections in use at a Texas chemical plant* were cyclically loaded with pressures from 2,500 to 9,000 psi 197,000 times without a leak. Although these connections are rated at 12,000 psi, two of them were tested at maximum static pressure to learn whether fatigue action had changed the ultimate capacity. Both held at pressures far exceeding rating and one held without leakage to 27,000 psi.

When high pressures are your problem, specify GRAYLOC connections for safety, low initial cost, low maintenance cost. Write for the whole technical GRAYLOC Test Data story today.

*Taken from a letter in our files

GRAY Tool Company

P. O. BOX 2291 HOUSTON, TEXAS
REpublic 4-1641

MAIL THIS COUPON TODAY

GRAY TOOL COMPANY
P. O. Box 2291 Houston, Texas
Please send me the GRAYLOC Test Data.
Name_____
Company_____
Title_____
Address_____
City_____ State_____

How To Do It . . .

and maximum flow rate are assumed. In practice, the flow rate can be obtained from the reading on the flow meter by multiplying the reading by a factor. This factor equals the maximum flow rate, which was assumed, divided by the maximum number on the flow meter scale.

Actual Operation. The flowing pressure and temperature, when in actual operation, seldom are the same as the assumed conditions used to size the orifice. Therefore, correction factors must be applied to correct the flow rates to actual conditions.

This can be done by using the formula:

$$\text{Corrected flow} = \text{Chart reading} \times \text{factor} \times F_t \times F_p$$

Where:

Factor = The maximum-design flow divided by the maximum number on the flowmeter scale.

F_t = Temperature correction which is equal to the square root of the design absolute temperature divided by the square root of the flowing absolute temperature.

F_p = Pressure correction which is equal to the square root of the flowing absolute pressure divided by the square root of the design absolute pressure.

A curve can be made to include the flowmeter reading, factor, F_t, and F_p. This eliminates the need for mechanical multiplication in solving for corrected flow.

To illustrate how such a curve can be made, take this example:

An orifice was sized so the maximum flow through it would be 20,000 scfh of a process gas. The orifice was sized on the basis of a flowing pressure of 40 psig and a flowing temperature of 60° F. The recording meter was to have a chart scale of 0-10. Therefore, the meter factor equals 2,000 scfh. When placed in operation, the flowing pressure varied from 35 to 45 psig and the flowing temperature varied from 40 to 80° F.

A curve, such as shown in Figure 1, was prepared as follows: In increments of 1 psig, from 35 to 45, pressure corrections were calculated. For example, the correction factor at 35 psig would be (assuming 14.6 psia as atmospheric pressure) the square root of 49.6 divided by the square root of 54.6, or 0.9531. Then, temperature corrections were calculated for 40, 60, and 80° F. For example, the correction factor for 40° F would be equal to the square root of 520 divided by the square root of 500 or 1.0198. For 60 and 80° F, the correction factors would be 1.0000 and 0.9813 respectively. Then, at a constant pressure, a combined factor which corrects for temperature and pressure was obtained by multiplying the pressure correction by the temperature correction for a certain temperature. In the example, the pressure correction for 35 psig, 1.0198, was multiplied by the temperature correction factors for 40, 60, and 80° F to obtain the values shown in the table.

A plot was then made of flowing temperature (top left ordinate) versus the combined factor (top abscissa) to give the flowing pressure line of 35 psig. The three points plot a straight line. Similar calculations were made for pressure lines from 35 to 45 psig and curves were plotted for these pressures.

The bottom portion of the curve where the chart reading lines are shown was obtained as follows: The chart reading was multiplied by the meter factor (2,000 scfh in this example) and the combined pressure-temperature correction factor to obtain flow rates at different combined factor valves. To obtain the chart reading line 7.0, three points were obtained by multiplying by 2,000 and combined factor values as follows:

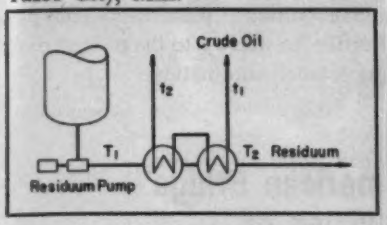
$7 \times 2000 \times 0.9300 = 13{,}020$ scfh
$7 \times 2000 \times 1.0000 = 14{,}000$ scfh
$7 \times 2000 \times 1.0500 = 14{,}700$ scfh

Then, three points were obtained by plotting 13,020, 14,000, and 14,700 scfh versus 0.9300, 1.0000, and 1.0500 respectively. This gave a straight line. This procedure was followed in obtaining the other chart reading lines.

Use of the Chart. When the chart is completed it can be used as follows: Assume the chart reads 6.3 and the gas temperature and pressure were 70° F and 38 psig, respectively. The path to follow in obtaining a corrected flow rate is marked with a dotted line. First, from 70° F on the temperature scale (upper left), follow a horizontal line across to the 38 psig line. Then follow a vertical line downward to the 6.3 chart reading line. Next, follow a horizontal line to the

left and read the corrected flow rate. In this example, the corrected flow would be 12,400 scfh.

This item was submitted by Marion L. Brown, Mississippi Chemical Corp., Yazoo City, Miss.



Find Flow Rate Without Meter, Using Temperature

An Italian "How To Do It" author says his company has no flow meter to measure the residuum from its topping plant. The thermal method used to measure yield, however, proves to be as exact as measurements from the residuum storage tank. It works like this:

In the residuum heat exchangers most of the heat lost by the residuum is added to the crude oil charge. Since there is no vaporization involved, the heat transfer may be written

$$(W_R)(c')(T_1 - T_2) = (W_c)(c'')(t_2 - t_1)$$

Where:

W_R = residuum rate, lb/hr
W_c = crude rate, lb/hr
c' = specific heat of residuum, Btu/(lb)(°F)
c'' = specific heat of crude, Btu/(lb)(°F)
T = temperature of residuum, °F
t = temperature of crude, °F

subscripts
1 = inlet
2 = outlet

Then on the basis of crude charge (ie, C = 100%), and $c' \cong c''$

$$W_R \cong (100)\left(\frac{t_2 - t_1}{T_1 - T_2}\right)$$

Example:

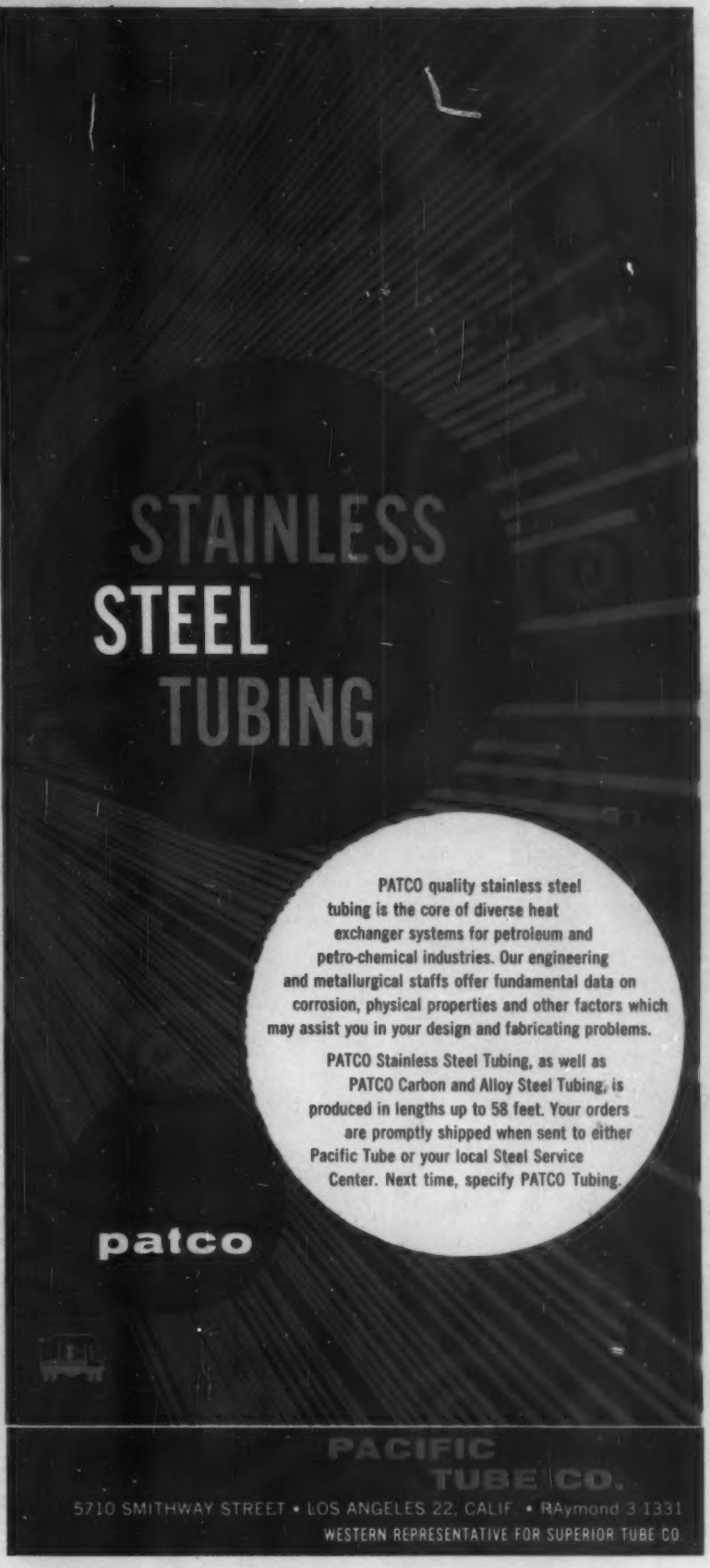
$T_1 = 581$ °F $\quad t_1 = 194$ °F
$T_2 = 320$ °F $\quad t_2 = 338$ °F

$$W_R \cong (100)\left(\frac{338 - 194}{581 - 320}\right)$$

$\cong$ 55.2 percent residuum yield

This idea was submitted by Vinicio C. Gerini, Via del Donatello 2, Trieste, Italy.

YOUR IDEAS ARE VALUABLE! At least $10 will be paid for each idea accepted for "How to Do It."


STAINLESS
STEEL
TUBING
PATCO quality stainless steel tubing is the core of diverse heat exchanger systems for petroleum and petro-chemical industries. Our engineering and metallurgical staffs offer fundamental data on corrosion, physical properties and other factors which may assist you in your design and fabricating problems.
PATCO Stainless Steel Tubing, as well as PATCO Carbon and Alloy Steel Tubing, is produced in lengths up to 58 feet. Your orders are promptly shipped when sent to either Pacific Tube or your local Steel Service Center. Next time, specify PATCO Tubing.
patco
PACIFIC TUBE CO.
5710 SMITHWAY STREET • LOS ANGELES 22, CALIF. • RAymond 3-1331
WESTERN REPRESENTATIVE FOR SUPERIOR TUBE CO.

For more data on advertised products, use Readers' Service Cards, last page.

at your service at Orange, Texas —

Modern, Complete Plate Fabricating Facilities

Our modern Orange, Texas, plant, one of the largest plate fabricating facilities in the country, is now producing all kinds of custom plate work—including stacks, pipe, bins, tanks and heavy-wall pressure vessels. And, being located on water, rail and truck routes, delivery is fast and shipping costs are low.

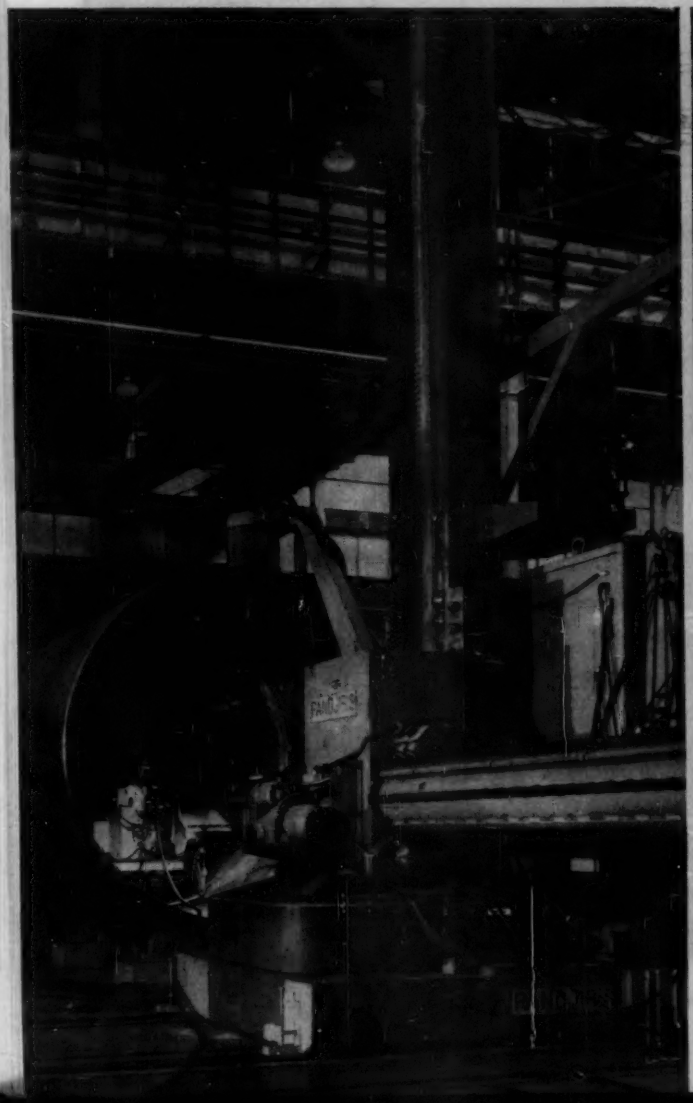
The plant is a two-aisle building, 177′ wide and 750′ long, with extended crane runways of 270′ and 200′ lengths at either end. Equipment includes seven cranes capable of lifting, in combined use, over 100 tons; large car bottom-heating and stress-relieving furnaces; heavy plate-bending rolls; a variety of presses and press brakes; the latest welding and X-raying equipment, plate shears, edge planer boring mills and drills. An inquiry to the nearest contract ing office will bring detailed information.

USS is a registered tradem

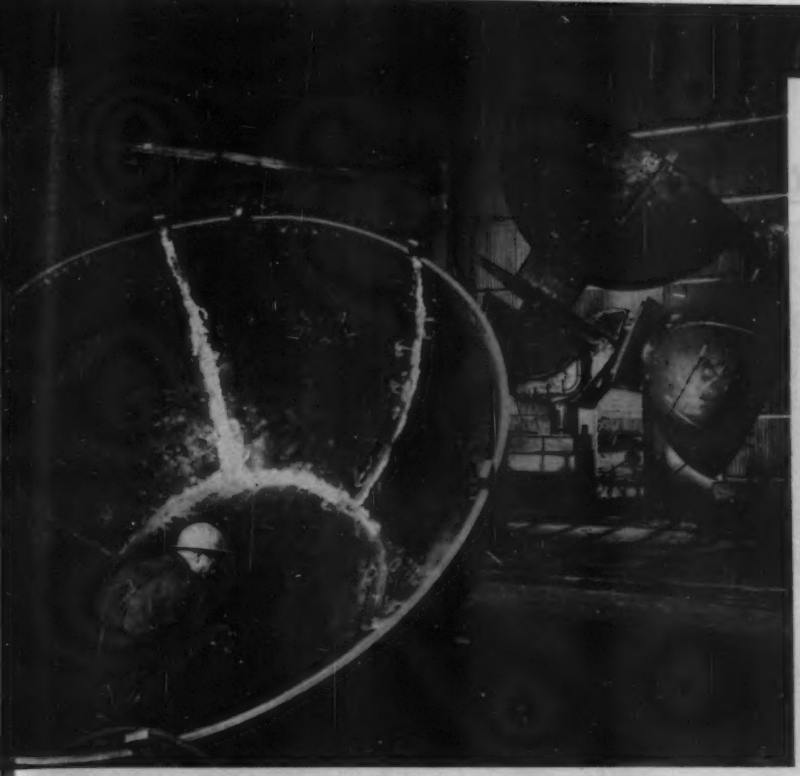
USS **American Bridge Division of United States Steel**

General Offices: 525 William Penn Place, Pittsburgh, Pa. • Contracting Offices in: Ambridge • Atlanta • Baltimore • Birmingham • Boston Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Elmira • Gary • Harrisburg, Pa. • Houston • Los Angeles • Memphis Minneapolis • New York • Orange, Texas • Philadelphia • Pittsburgh • Portland, Ore. • Roanoke • St. Louis San Francisco • Trenton • United States Steel Export Company, New York

Automatic welding inside circumferential butt joint of two 1¼" plates with boom welder.



Pressing 1½" plates on 2000-ton press for hemispherical heads.

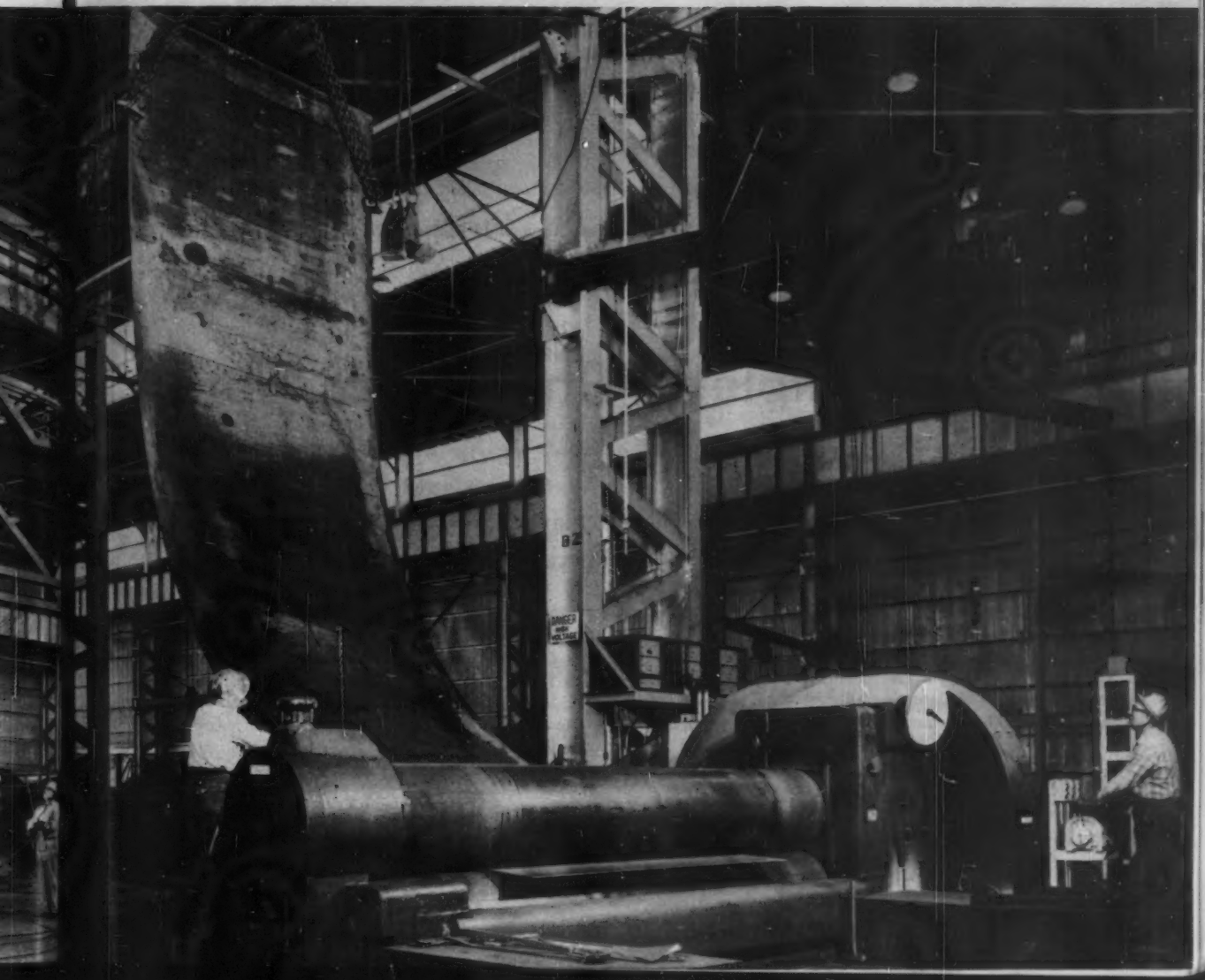


Inside of 9'-6" dia. x 1 1/16" thick hemispherical head being ground smooth.

Complete Construction Service

Possessing the most complete range of construction equipment in the industry and skilled personnel backed by over fifty years of experience, American Bridge is prepared to erect any product it fabricates.

Rolling 96" wide x 1/16" thick plate for knock-down storage tank.



Who's Building...

New MEK paraffin-wax plant handles eight different feedstocks through 14 operations for full line of paraffin waxes.

Atlantic Completes Philly Wax Plant

New $18 million facility is one of world's largest, increasing Atlantic's wax capacity by 80 percent

One of the world's largest paraffin wax manufacturing plants has started operation at The Atlantic Refining Co.'s Philadelphia refinery. It cost $18 million including auxiliary facilities, and will increase Atlantic's paraffin wax production capacity by more than 80 percent, with an output of 265 tons of wax per day.

Designed and built by Badger Manufacturing Co., the plant uses the Methyl Ethyl Ketone solvent dewaxing process. Also installed was a new automatic molding machine that can form wax slabs at 15,000 pounds an hour. Mechanized palletizing and packaging operations have eliminated manual handling of the wax.

The plant has a charge stock capacity of 8,000 to 15,000 bpd, depending upon the type of wax distillate being run. It can handle eight different feedstocks (light, medium and heavy waxy distillates from a vacuum pipe still) through 14 operations to produce a full line of refined and semi-refined paraffin waxes. The refrigeration system uses propane.

In the new MEK plant, special wax distillates are mixed with a sol-

SAFETY IN THE RIGHT PERSPECTIVE

with Flexitallic Spiral-Wound Gaskets

In this enlarged sectional view, you can see the Spiral-Wound Gasket construction originated by Flexitallic in 1912. And you can see Flexitallic Blue, the blue dye in the Canadian asbestos filler, which is the mark of an engineered Flexitallic Gasket.

Flexitallic means sealing at its safest. You get performance you can depend on throughout all pressure/temperature ratings, because the compression characteristics of the gasket are always related to the pressure/temperature ratings of the flanges with which they are assembled.

When fluids are confined in a critical pressure/temperature range . . . when flanged joints are subject to thermal and mechanical shock, vibration, weaving, and other joint stresses . . . engineers demand the maximum in gasket performance.

That's why they specify Flexitallic Spiral-Wound Gaskets.

FLEXITALLIC GASKET CO.
8th & Bailey Sts. Camden 2, N.J.

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Flexitallic is a registered tradename. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler.

For more data on advertised products, use Readers' Service Cards, last page.

A MAJOR

The unit shown above delivers 2000 cfm of oxygen compressed from atmospheric pressure to 120 psia, when operating at design speed of 30,000 rpm. It is a two-stage, intercooled centrifugal compressor, direct driven by a 600-hp Elliott steam turbine. Overall length, about 36 inches. Other designs and pressures are available. Geared electric motor drive optional.

Turbine-driven centrifugal oxygen compressor during factory test. First unit was subjected to 177 hours of rigorous test, 117 of these at design speed (30,000 rpm) or higher. After 106 starts and stops, no measurable wear could be detected on any bearing. This testing also includes complete tests of direct-connected steam turbine, governed by an electro-pneumatic governor requiring no outside power source.

ELLIOTT
Company

JEANNETTE, PENNSYLVANIA

BREAKTHROUGH

in oxygen compressor design!

ELLIOTT'S NEW CONCEPT

—eliminates previous hazards
—offers substantial savings

New standards of safety and economy are established by this new Elliott oxygen compressor, designed for low flow at high head (high pressure ratio). Compressor and turbine bearings are made of aluminum oxide and are water lubricated, thus eliminating entirely the danger of explosion caused by lubricating oil contamination.

The perfection of water-lubricated "ceramic" bearings is the culmination of long research and development by Elliott engineers. Their achievement eliminates the need for elaborate and complex seals. This new concept in compressor design marks a distinct forward step in safety, efficiency and reliability.

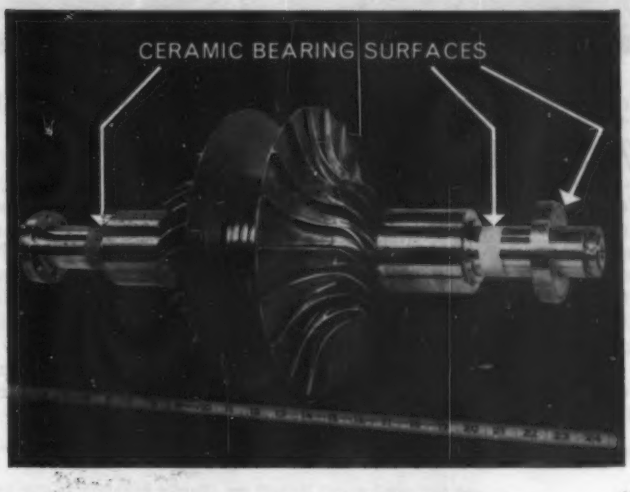
Elliott compressor specialists will be glad to give you complete details of this new line of compressors. Call the nearest Elliott office, or Compressor Department, Elliott Company, Jeannette, Pennsylvania.

SAFE! Completely water lubricated, no risk of explosion from lube oil contamination. Casings are fabricated from stainless steels, which will not burn in an oxygen atmosphere. Another safety feature is the new highly-accurate mechanical overspeed trip for turbine drive.

SPACE SAVING! Occupies but a fraction of the space of equivalent reciprocating equipment. Light in weight, this compact unit requires only simple and inexpensive foundation.

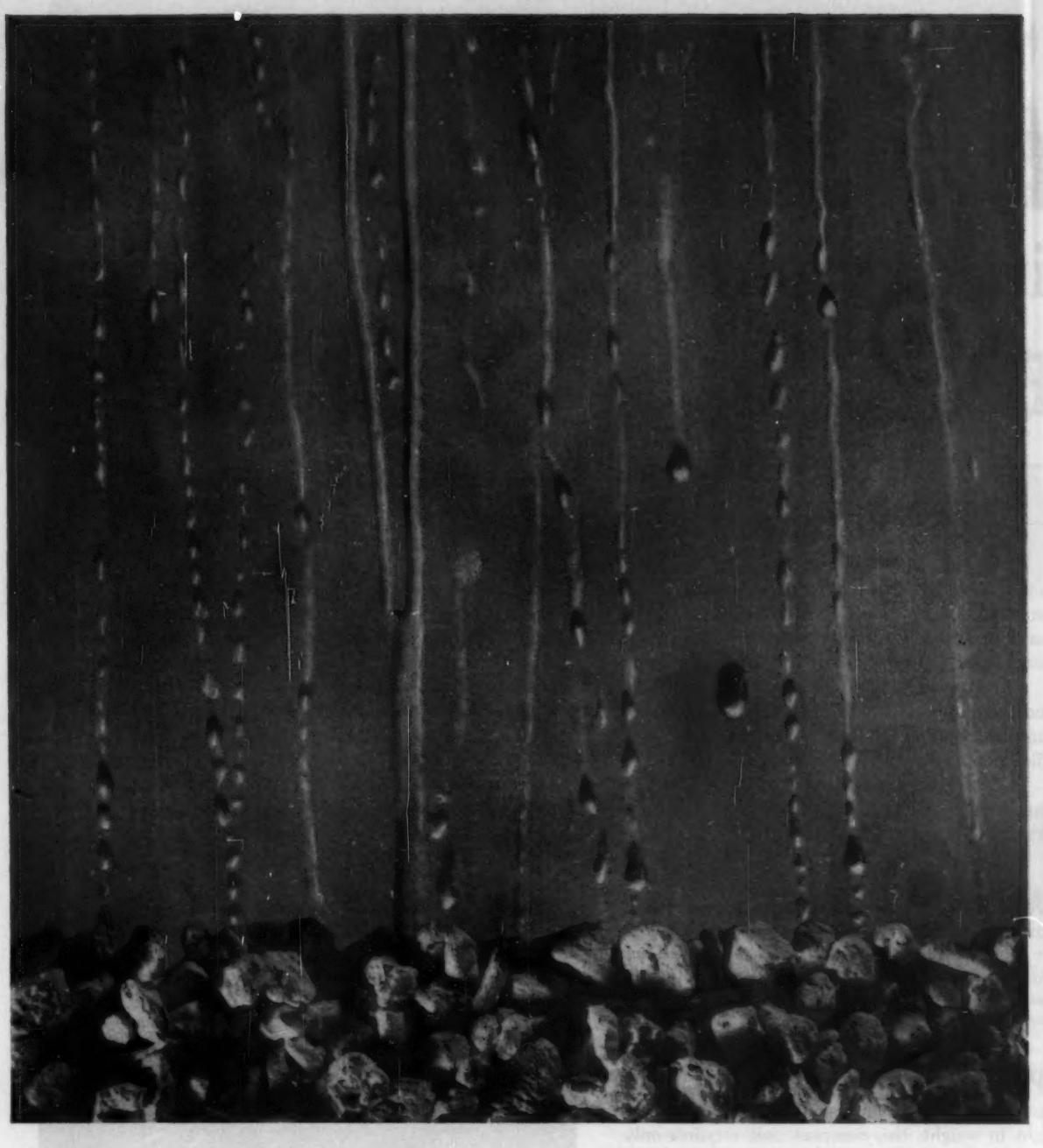
RELIABLE! Elliott's centrifugal compressor experience extends back to the early years of this century. Elliott turbochargers (essentially air compressors), introduced in 1940, serve over 16,000,000 hp of diesel engines. Many of these units operate at speeds exceeding 40,000 rpm. No manufacturer can offer a broader background in centrifugal compressors.

SIMPLE! No reciprocating parts, no packings to wear, no complex seals. The only moving part is the rotor, shown below. The Elliott compressor offers the simplicity and ease of maintenance possible only with a rotating machine. And water-lubrication greatly simplifies the lubrication system.



P9-1

For more data on advertised products, use Readers' Service Cards, last page.



Unwanted water may ruin your product or process unless you

mix imagination with Alcoa Activated Aluminas

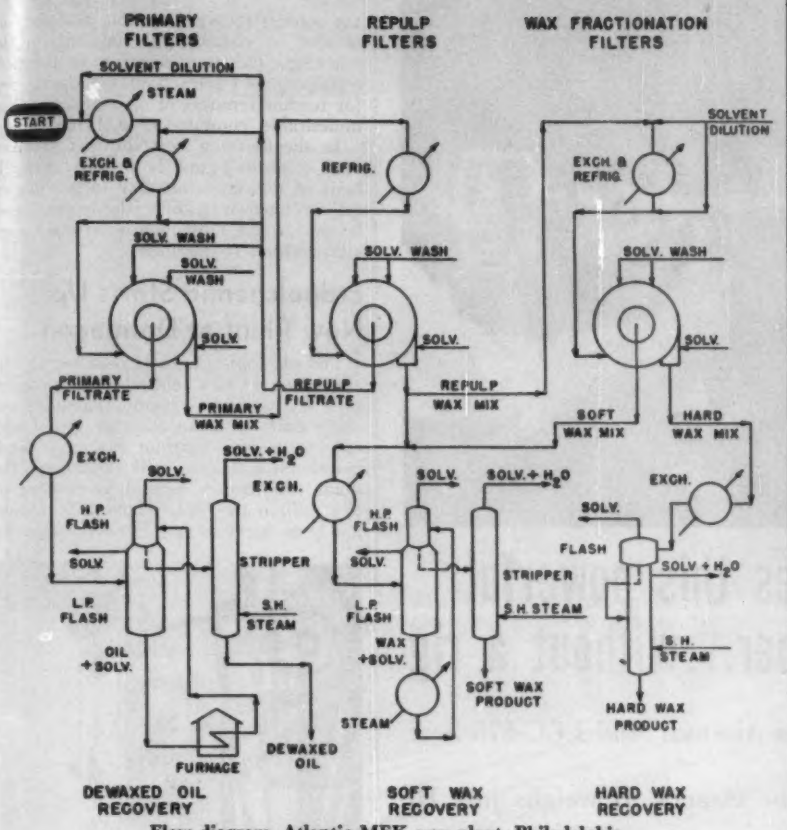
Water you can't remove is a sure bet to destroy the efficiency of a process or the quality of a product, or corrode the equipment. But you can count on drying up the last drop of unwanted water when you mix imagination and engineering with ALCOA® Activated Alumina. Here is the oldest, most thoroughly proved drying agent available. It makes possible dew points to minus 100°F and below. And because it can be saturated and reactivated almost endlessly without loss of capacity, it cuts drying costs substantially. See how quickly it can solve *your* dehydration problems. You'll join the thousands who've discovered it pays to *mix imagination with Alcoa Aluminas . . . to make a new product or process possible, an old product or process better*. To get product details, outline your desiccant application in a letter to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 708-G Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA CHEMICALS

For exciting drama, watch "Alcoa Theatre," alternate Mondays, NBC-TV, and "Alcoa Presents," every Tuesday, ABC-TV

For finer products . . . let Alcoa add new dimension to your creative thinking

Building . . .



Flow diagram, Atlantic MEK wax plant, Philadelphia.

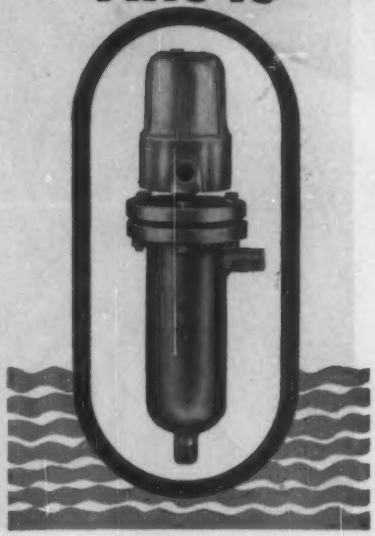
vent and chilled to about 10° F in power-driven scraper exchangers and chillers where the wax is crystallized out. This cold wax-oil-solvent mix then is fed to a battery of rotary vacuum filters. There, the liquid is drawn through canvas-covered drums and the wax slurry is retained on the canvas.

The wax on the drum is washed with additional solvent and continuously removed. The oil-solvent mix that is drawn through the filter is stripped in

FACT SHEET
THE ATLANTIC REFINING COMPANY'S
NEW PARAFFIN WAX PLANT

LOCATION: North Yard, Philadelphia Refinery
DESIGNED AND CONSTRUCTED BY: Badger Manufacturing Company
LICENSED BY: Texaco Development Corporation
COST:
a. M.E.K. Plant and Immediate Auxiliaries..... $11,500,000
b. Site Clearance, tankage, and finishing and packaging equipment..... 6,500,000
TOTAL COST..... $18,000,000
CONSTRUCTION TIME: 13½ Months
TOTAL AREA: (M.E.K. Plant) 4.2 Acres
CHARGE STOCK CAPACITY: 8,000 to 15,000 barrels per day
RATE OF WAX OUTPUT: 265 tons per day
REFRIGRATION SYSTEM: Propane—3,000 tons
UTILITIES:
a. Fuel consumption – 475 gallons per hour
b. Steam consumption – 165,000 pounds per hour
c. Power consumption – 3,370 KW
d. Cooling water – 10,000 gallons per minute
FILTERS: Fourteen filters—700 square feet each—total of 9,800 square feet
RELATED EQUIPMENT: Wax slabbing and packaging—15,000 pounds per hour.

This is



LEVEL MASTER®

The UNFAILING Liquid Level Control!

The ability to function with *continuous, sensitive control* with liquids is the standout feature of Level Master. The "brain" of Level Master is the unique Bell Magnetic Proximity switch incorporating a permanent Alnico V magnet that responds instantly to changes in liquid level!

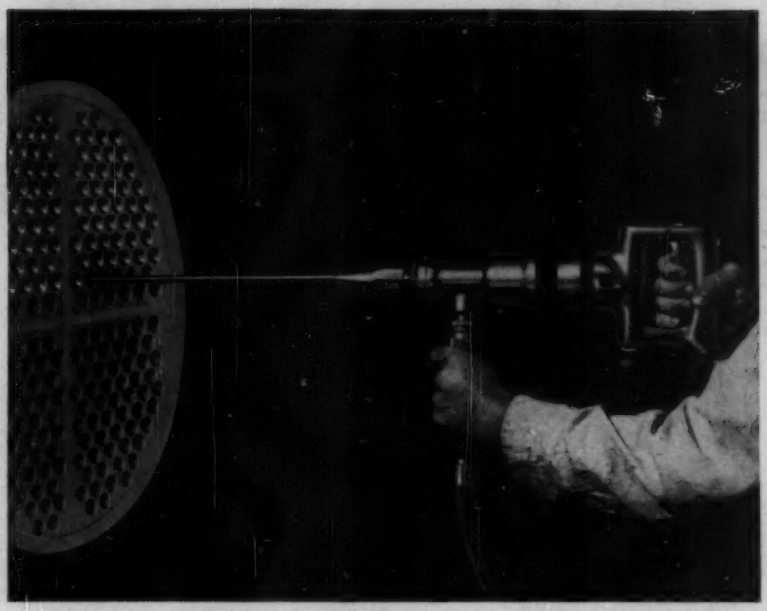
- *Models for all types of liquids.*
- *Horizontal, vertical, external mountings.*
- *Precision engineered for long life operation.*

For full information consult your Level Master representative or write directly to:

JO-BELL PRODUCTS, INC.
5456 W. 111th St. • Oak Lawn, Ill.
Phone GArden 5-0240

Jo-Bell Products, Inc. Dept. C
5456 W. 111th St., Oak Lawn, Ill.
Send full information on Level Master and name of nearest representative.
My name_____
Company_____
Address_____
City_____ Zone____ State____

For more data on advertised products, use Readers' Service Cards, last page.



One man handles this powerful Airetool tube cleaner...without a rig

There's no other tool like this Airetool Model CC-475 heat exchanger and condenser tube cleaner. It weighs just 10 lbs. One man handles it easily — without a supporting rig. Yet, it's powerful enough to clean all severely clogged tubes up to 1″ diameter. Built-in flushing system washes away debris, cools drill head — keeps work moving at a fast pace.

You get this same time and cost-saving performance from Airetool straight tube cleaners and pneumatic, as well as electric tube expansion control systems. Write for Bulletin 66. ***The Airetool Mfg. Co., Springfield, Ohio***

BRANCH OFFICES:
New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.

REPRESENTATIVES
in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.

EUROPEAN PLANT:
Vlaardingen, The Netherlands

CANADIAN PLANT:
Brantford, Ontario

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

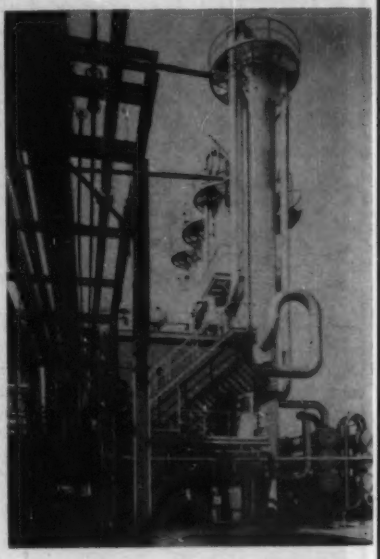
Building . . .

the solvent recovery section, and the oil is sent to paraffin oil finishing or to cracking. The wax slurry goes through repulping and refractionating operations for further removal of oil and any other undesirable components still remaining.

In the finishing step, the wax receives acid treatment and is filtered through beds of diatomaceous clay to produce a fully refined wax. Special blending can be performed subsequently to meet specific end-use requirements.

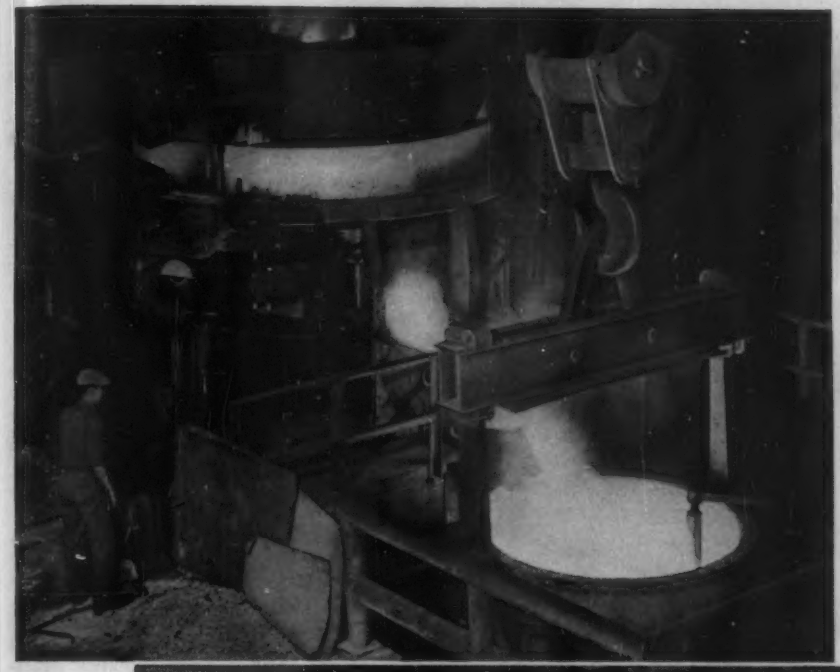
Erdoelchemie Starts Up New Plant at Dormagen

Erdoelchemie G.m.b.H. has begun operation of it's new refinery at Dormagen, near Cologne, Germany. Facilities include units to make ethylene glycol and ethylene oxide, separate gas, and crack petroleum fractions. Still expanding, the plant will involve a total investment of $71 million by 1961. About $29 million has been spent so far. Eventual capacity



is slated to reach 200,000 tons a year of feedstock for a 45,000-ton-per-year ethylene production. An additional ethylene plant will soon go under construction and be completed this year. Combined capacity of the two plants will give Erdoelchemie the largest ethylene oxide plant outside the United States, according to Scientific Design Co., which handled engineering and design.

Standard-Vacuum Oil Co. has awarded Fluor International, S.A., the prime contract for a $28-million petrochemical plant to be built at Altona, near Melbourne, Australia, this year. Working with Fluor will be Utah Australia Ltd., a subsidiary of Utah Construction Co., Salt Lake City. The two companies will handle engineering and construction of a four-plant petrochemical complex's key unit. The plant will supply high-purity chemicals for use by three other units to produce polythylene, styrene, and GRS



Tapping a 50-ton arc furnace at B&W Barberton works.

Rigid quality control is maintained through all phases of production down to final inspection.

Why B&W Hollow Forged Piping Gives Long, Dependable Service

At B&W, quality control of Hollow Forgings is constant from initial melt to final inspection of the finished product. This *integrated* control is a big reason why B&W Hollow Forged Piping is the most practical choice for main steam, reheater, feedwater, and other heavy-duty high-pressure or high-temperature lines.

Testing at B&W includes analysis and grain structure examinations—hydrostatic test—and ultrasonic test as standard procedure. What's more, B&W machines the outside surface of every forging, to assure good appearance and ease of fabrication.

B&W Hollow Forged Piping is available in a wide range of sizes, in carbon, alloy and stainless grades, and is made to ASTM specifications. There is a size and grade close to your optimum design requirements. For more about how B&W Hollow Forgings meet your needs best, write for Bulletin S-16. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

S-475-HF

B&W

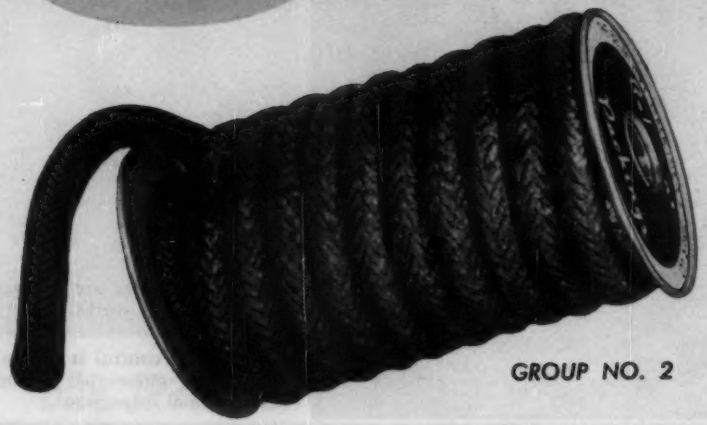
THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

For more data on advertised products, use Readers' Service Cards, last page.

MOST COMPLETE LINE

Eleven Product Groups Serve Every Sealing Need



GROUP NO. 2

Valve Stem Packings

Braided and twisted Asbestos types and monel wire inserted braided asbestos over plastic core, for low, medium and high pressure steam at temperatures up to 800° F, and for hot water, hot oil, gas and air service.

Also, for valves handling corrosive chemicals, Belmont offers Teflon* molded valve rings; braided Teflon yarn packings; braided Teflon-impregnated blue and white asbestos Packings; Shredded Teflon Plastic Packings; for temperatures to 500° F.

See your Belmont Distributor or write for the name of the one nearest you.

OTHER BELMONT PRODUCT GROUPS

1. High Pressure Asbestos Packings
3. Rotary Pump Packings & Seals
4. Criss-Cross Braided Packings
5. Hydraulic Packings
6. Bel-Vee V-Rings
7. Sheet Packings
8. Gaskets
9. Metallic Packings
10. Plastic Packings
11. Expansion Joints

*du Pont Trademark

MOST CONVENIENTLY AVAILABLE

Nationwide Industrial Distributor Organization Provides On-the-Spot Service

BELMONT

The Belmont Packing and Rubber Company
Butler & Sepviva Streets, Phila. 37, Pa.

Building . . .

synthetic rubber. The project will cost $50 million.

Vacuum Oil Co., Pty. Ltd., a subsidiary Standard-Vacuum, will own and operate the unit to be built the Fluor-Utah group. Two of the other units represent Union Carbide Corp. and CSRC-Dow interests. The latter is jointly owned by Dow International and an Australian company—CSR Chemicals. The third unit, the GRS rubber plant, is to be built by Australian Synthetic Rubber Co., Ltd., a subsidiary of Vacuum.

Process design for Vacuum's key plant is underway in the United States. Engineering studies have begun and construction will begin late in 1955 and be completed by mid-1961. Output will include 20,000 tons of ethylene a year and enough butadiene for 30,000 tons of synthetic rubber.

Petroleos Mexicanos has awarded a $21-million contract to The Lummus Co. for expansion of Pemex's Salamanca refinery, and for a 220-ton-per-day anhydrous ammonia plant there. The refinery expansion consists of an atmospheric and vacuum distillation unit, catalytic cracking, gas recovery, catalytic polymerization and treating units, revamp of some existing process facilities, and various offsite additions. Lummus will design, engineer and supervise construction of installations. The anhydrous ammonia plant is part of Pemex's expanding petrochemicals program and the refinery expansion is to enlarge facilities for Mexico's growing gasoline, distillate, vehicular and industrial fuels demand.

Japanese Government has approved a technical assistance agreement between Tears Engineers and Iino Shipbuilding & Engineering Co., Ltd., Tokyo, for design and construction of two chemical process plants in Japan. The agreement is one of few such agreements on process plant design in effect in Japan. The two firms will design, fabricate, and construct a $6-million synthesis gas production plant for Nitto Chemical Industry Co., Ltd., chemical manufacturer of Tokyo, Yokohama, and Hachinohe.

The plant eventually will produce 125 tons per day of synthetic ammonia. Synthesis gas will be produced by partial oxidation of heavy fuel oil, using Texaco Development Corp's. process.

Iino-Tears have also been selected as supervising and design engineers for a major portion of a $20-million Kyowa Fermentation Industry Co., Ltd., project at Ube, Japan, which will produce butanol and octanol from petroleum naphtha. Iino-Tears will handle the acetylene and ethylene production sections, which will cost $6.5 million.

Devon-Palmer Oils Ltd. has borrowed $3.5 million to finance its share of a $9.5 million sulfur-gas project to be owned jointly with Texas Gulf Sulphur Co. The plant will be in the Okotoks gas field, southeast of Calgary, Alta. Field production facilities and a gas gathering

YOU CAN'T BUY A MARLEY CLASS 600 DOUBLE-FLOW *that won't meet performance*

Full-performance towers are as ethically fundamental as "twelve bananas to the dozen." That is why Marley zealously conforms to this single standard: "You can't buy a Marley Class 600 Cross-Flow that won't meet performance."

That is why an important part of every Marley Class 600 Double-Flow or Single-Flow proposal reads: "Every purchaser is urged to make thermal performance tests of his Marley tower." Each year more cooling tower buyers are including test provisions in their specifications as the one possible method of determining satisfactory performance—of mutual importance to buyer and builder.

Backed by 20 years of Cross-Flow performance research, Marley has complete confidence in its selections for any duty, so customers are given all necessary assistance to facilitate testing by whatever standard is selected. Tests conducted by Marley engineers are scheduled promptly and must receive customer's full concurrence.

Marley welcomes tower tests as an opportunity to present the quality of Class 600 towers to industrial purchasers by publishing annually the consecutive results of the year's testing program. ALL test results are made public—none are deleted.

During 1958, 22 tests were conducted. Of these, 18 indicated capacity in excess of specification. Four tests were deficient, the greatest deficiency being .54° of cold water temperature specified. The Marley guarantee provides that these four towers be modified to deliver full performance without added cost to the owner.

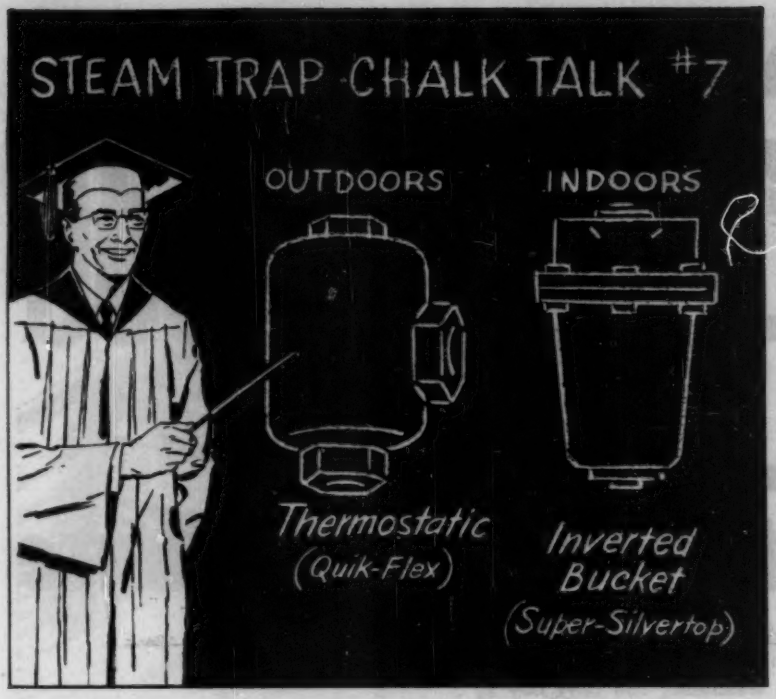
Your Marley sales engineer will be glad to supply you copies of test results; also Marley's brochures "Test Your Tower" and "Analyze Your Bids". If more convenient, request them from...

MARLEY

The Marley Company

Kansas City, Missouri

For more data on advertised products, use Readers' Service Cards, last page.



Which design of trap is best for refineries?

- For outdoor refinery uses, the Anderson Quik-Flex Thermostatic Steam Trap fulfills all requirements of high condensate capacity, combining non-freeze features. Anderson Quik-Flex Traps will handle up to 31,000 pounds of condensate per hour. Their self draining design enables Anderson to guarantee every trap for two years against damage by freezing.

For indoor refinery applications, Anderson Super-Silvertop inverted bucket traps with their exclusive guided bucket, result in positive leakproof valve seating and longer life.

Be sure your refinery traps are engineered for each application. Send for Anderson's new catalog, "How to Select Steam Traps and Other Fluid Specialties". It contains selecting and sizing steam trap data on all types of pipelines and steam units, ... indoors or outdoors.

A TRAP FOR EVERY PURPOSE

THE V. D. ANDERSON COMPANY
division of International Basic Economy Corporation
1953 West 96th Street • Cleveland 2, Ohio

Please send without obligation your 36-page steam trap engineering catalog, "How to Select Steam Traps and Other Fluid Specialties".

Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____

ANDERSON QUIK-FLEX

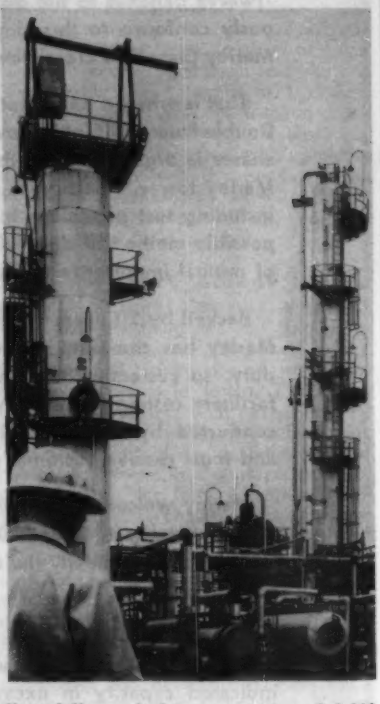
Building . . .

system are ready for operation, and four gas wells have been connected to the gathering system. It is planned that ultimately all gas reserves in the field will be processed through the Okotoks plant.

When on full stream, the unit will process 30 MMcf of raw gas per day, yielding 12.5 MMcf of saleable residue gas. This will be delivered to Canadian Western Natural Gas Co. Ltd. On a yearly basis, saleable products will amount to about 4.25 billion cubic feet of "sweet" gas and 126,000 long tons of sulfur. Devon-Palmer and Texas Gulf each will initially receive at least 42½ percent of the plant's production. Texas Gulf will operate the plant, and Devon-Palmer will operate the gas wells and gathering system.

New Distillate Desulfurizer For British American Oil

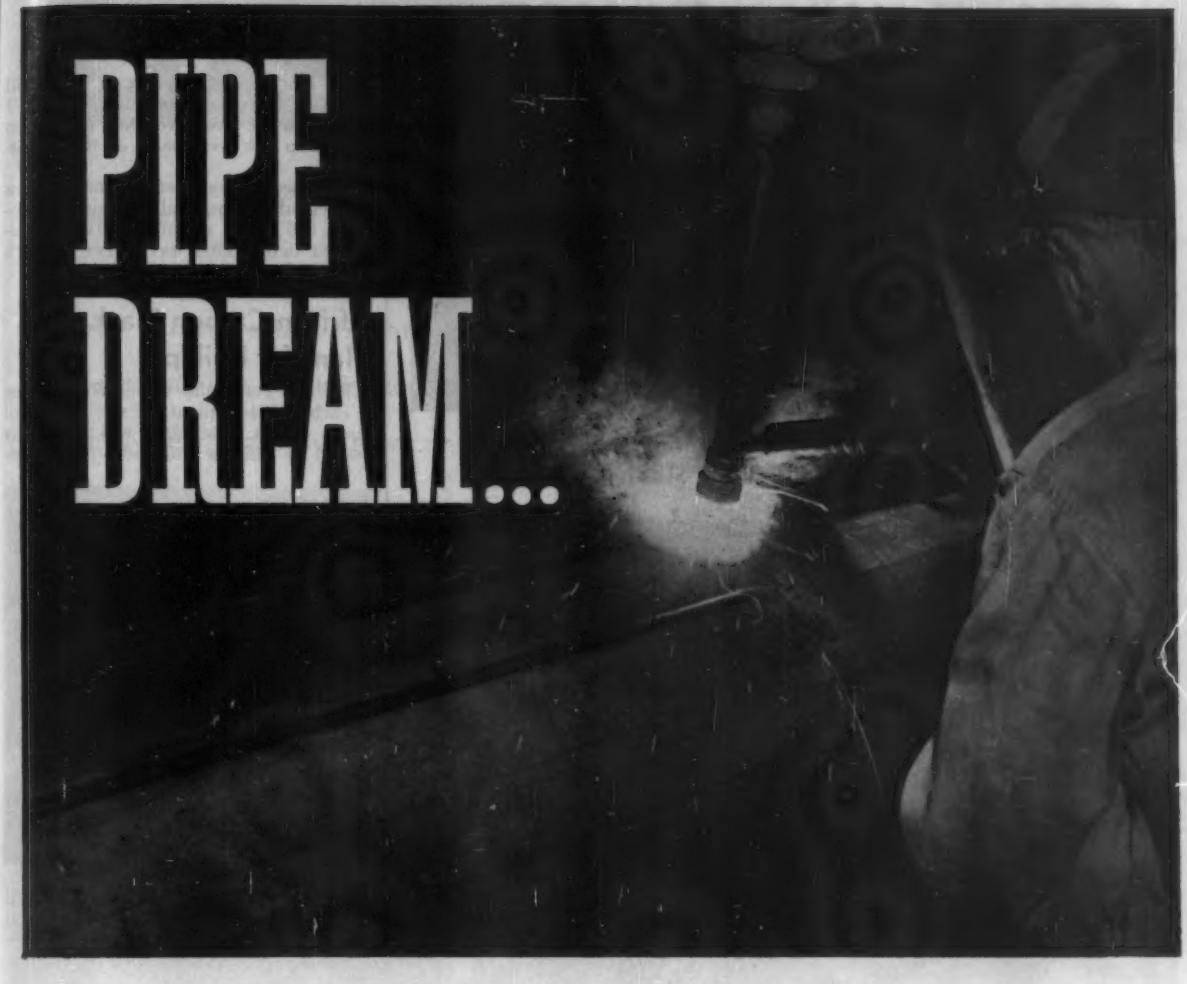
A new middle distillate desulfurizer, said to be the first in Ontario, is being installed at British American Oil Co's. Clarkson refinery near Toronto. The mil-



lion dollar unit has a capacity of 8,000 bpd., and will upgrade the quality of B-A heating oils and diesel fuels.

The Dow Chemical Co. plans to spend $12 million for new construction at Plaquemine, on the Mississippi River. Engineering and construction work will start immediately. The expansion program includes a polyethylene plant, scheduled to go on stream in about 18 months, and facilities to produce vinylidene chloride and Chlorothene, with the production target about mid-1961.

With completion of the Louisiana divi-



...UNIONARC Welding saves $7000 on one production run

UNIONARC Welding—LINDE's new electric welding method for steel—increased production by 300% and saved a western pipe mill $7000 on a single run of steel pipe. Replacing covered electrode methods, UNIONARC Welding is expected to save this company $150,000 a year.

UNIONARC Welding uses a continuously-fed wire electrode, magnetically coated with flux and shielded with carbon dioxide gas. It has three times the speed and weld penetration of covered electrode welding. And UNIONARC Welding gives you "finished", X-ray quality welds and low hydrogen deposits—in all welding positions.

See for yourself—ask your nearest LINDE representative to *prove* that UNIONARC Welding slashes time and labor costs over conventional methods. Call your local LINDE office today! Or write Dept.PR-7, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde TRADE-MARK

UNION CARBIDE

"Linde", "Unionarc", and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

For more data on advertised products, use Readers' Service Cards, last page.

manufacturer of high alloy steel products for the petroleum industry

4" cast 25-12 return bends

Avondale's foundry division can produce high alloy steel castings weighing up to 12,000 lbs. each. A special CF4 low carbon 18-8 alloy is produced regularly. In addition, Avondale has the facilities and experience to fabricate pressure vessels of carbon steel, stainless steel or clad steel of almost any thickness. Our facilities include one of the largest heat treating furnaces in the United States.

Write for our complete brochure, *Foundry Work—Steels, Alloys & Non-Ferrous*

AVONDALE
MARINE WAYS, INC.
VERSATILE BUILDER ON THE MISSISSIPPI
P. O. Box 1030 • New Orleans, La. • UN 6-4561

Building . . .

sion's first expansion program, Dow will have an investment of more than $77 million in the new diversified production center on the west bank of the Mississippi.

The new polyethylene plant's process is licensed by Imperial Chemical Industries, Ltd., with refinements and improved design after extensive research and production.

African Carbon Black Plant for Phillips

Phillips Petroleum Co. is constructing a carbon black plant in the Union of South Africa. The plant will be jointly owned by Phillips and Industrial Development Corp. of South Africa. It will have a 22-million pound-per-year initial design capacity, and will use an oil-furnace-black process developed by Phillips.

The Soviet Union reportedly plans to buy a $6-million chemical plant in England from Vickers-Armstrong Engineers and Petrochemical Engineering Co. The plant is to be delivered by late, 1960.

Syria has completed its 20,000-bpd refinery, which is receiving crude oil from Iraq Petroleum Co. The nation is also planning a 4,000-bpd plant at Qamishli, which will operate on crude from the Karachuk field.

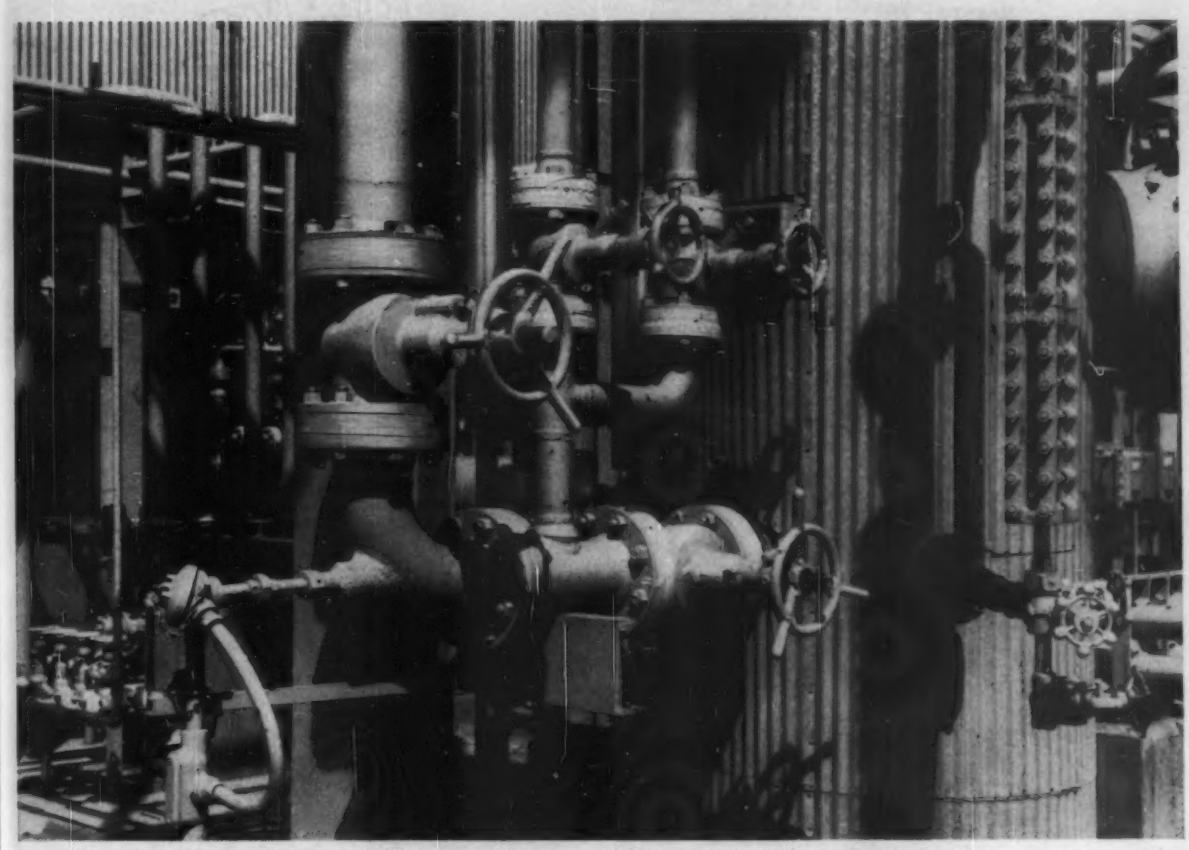
CM&M Gas Products Plant, Inc., is planning a $700,000 expansion for its Wise County, Texas, gas processing plant. The project will increase the plant's capacity from 100 MMcf of raw gas per day to 150 MMcf. Liquid recovery will also be upped. The expansion is slated for completion late this year.

Texas Natural Gasoline Corp. has contracted with Gulf Interstate Co., Houston, to construct a natural gas liquids plant on Columbia Gulf Transmission Co.'s natural gas line, which extends from Louisiana to Eastern Kentucky. Capacity, exact location, etc., has not been finalized and an announcement will be made later regarding these details. The plant will be placed on stream in early 1960. Texas Natural will own,

For more data on advertised products, use Readers' Service Cards, last page.

STOP PRODUCT CONTAMINATION BEFORE IT BEGINS BY USING ORBIT FORGED STEEL VALVES

Because of the non-lubricated positive closure seating principle used in the Orbit Valve, costly maintenance and the possibility of fluid contamination carry-over from valve lubricants which lower catalyst efficiency has been eliminated. Lubricant is not required for any part of the valve's mechanism that comes in contact with fluid being handled in cavity of valve.



Service shown here: Hydrogen Plant — Makeup Unit to Dehydrator.

Literature: Write Department B for Catalog 58-B and Service Manual No. 58.

Source: Available through your favorite industrial supply house.

ORBIT VALVES®

ORBIT VALVE COMPANY

P. O. BOX 699 • TULSA, OKLAHOMA • Phone LUther 4-4761 • TWX TU 925

For more data on advertised products, use Readers' Service Cards, last page.

189, 017, 0

Telegraphic Address
"CITYICE"

Telephone
No. 86479

THE CITY ICE & COLD STORAGE CO.,
12, GENERAL PATTER'S ROAD,
MOUNT ROAD,
MADRAS, 2
INDIA

16 August 1958.

Messrs. United States Hoffman Machinery Corpn,
Air Appliance Division,
103 Fourth Avenue
New York 3, N.Y.

RECEIVED
AUG 25 1958
INDUSTRIAL EQUIP

Gentlemen: Subject- Hoffman Centrifugal Blower
with motor-direct coupled
Frame No.4008- Type BBA
Serial No.1878-Size BL 20.

We are in receipt of your kind enquiry dated August 5,1958 regarding the working condition of the above blower and motor which were purchased by The City Ice & Cold Storage Co, Madras,2 sometime in 1937. Accordingly we take pleasure to report to you and certify as under:-

1. Ever since the installation in our factory the above blower and motor in 1937, that is for nearly 21 years now, the blower has given us perfect satisfaction without any complaint whatsoever.

2. During this long period of 21 years we never had an occasion to open even a bolt or nut for the purpose of cleaning the machine for for the purpose of looking in for any unsatisfactory working.

3. Beyond greasing the bearings regularly once every three months no further attention was ever needed of us; and no repairs, removal or replacement of any single part has been made.

4. The blower has been working all the 24 hours of the day for 9 months in the year, and for the rest 3 months it works 12 hours a day.

5. The blower and the motor (direct coupled) continues to be in the same original form since its installation in 1937 and we have never come across an efficient and long standing blower similar to this anywhere in the market.

6 Last but not the least, we strongly recommend this blower to ice manufacturers all over the world because it is very efficient, long standing and very economical in use.

Regarding the actual pictures of the unit in operation, we shall be attending to this aspect and send you photo copies in due course.

Thanking you for your kind enquiry,

Yours faithfully,
Nariman K. Irani
(Nariman K.Irani)

189,017,047 miles*

without a single repair and still going strong!

* miles.

In many manufacturing plants, profit margins are dependent on a number of variables. Perhaps the most significant of these is the cost of materials, labor and *down-time.*

Output up-costs down

Where operating and production schedules depend on the unfailing delivery of clean, dry air or gas at constant pressure, Hoffman Multistage Centrifugal Blowers and Exhausters actually reduce costs, save materials and are free of down-time. For example, the Hoffman Blower pictured here has been in daily use for *22 consecutive years* without the need for repairs of any kind. Despite rugged climatic conditions, it runs its regular schedule of 24 hours a day nine months of the year and 12 hours a day the remaining three months. Over the 22 year period, it is estimated that the unit's impellers have traveled the equivalent of 395 trips to the moon and back, a distance of more than 189,017,047 miles.

Efficiency with economy

Economical operation with Hoffman Million Mile Blowers and Exhausters is assured since power is consumed only in proportion to the actual volume of air or gas handled. The absence of internal wearing surfaces and the lubrication of bearings in outboard mounted housings makes contamination of air or gas impossible. Pressure differential remains constant throughout the range of capacity and air flow is smooth, free of pulsation.

Cutaway view of Hoffman Blower.

Applications

The many production processes for which Hoffman Blowers and Exhausters provide clean, dry air or gas at constant pressure include:

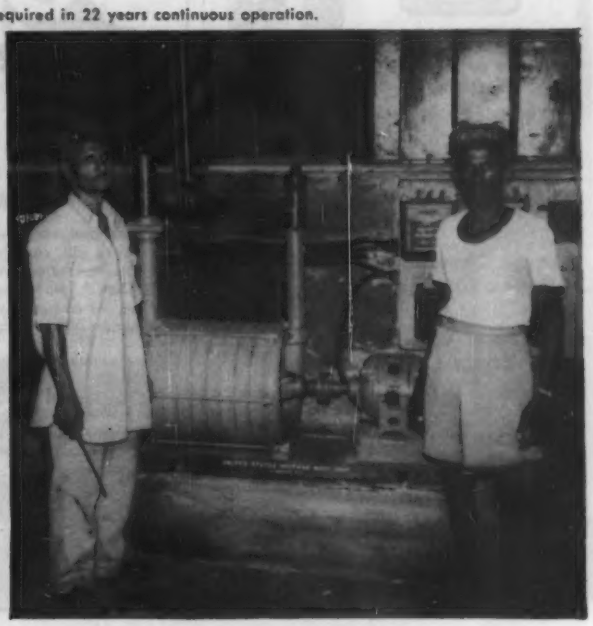
- air squeegee for continuous liquid removal
- vacuum cleaning
- pneumatic conveying
- continuous drying operations
- agitation of plating solutions
- sewage and industrial waste treatment
- ore flotation
- oxidation of oil and asphalt
- combustion
- glass blowing
- raw water ice plants
- production washing of foods
- circulation of liquids
- gas blowers and boosters
- yarn drying
- wrapping, packing and stacking machines
- ejection of stampings from continuous punching machines

Free service

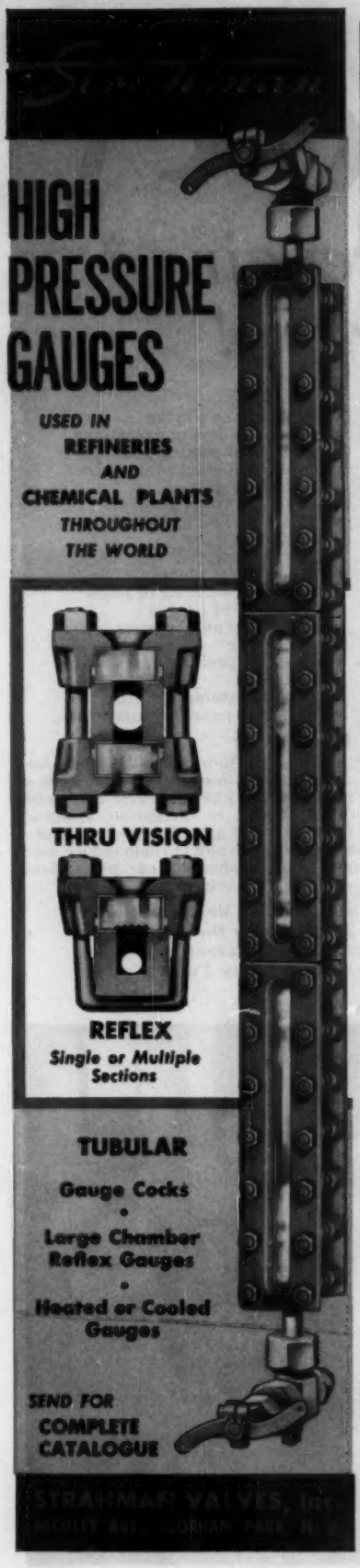
Hoffman Blowers and Exhausters are available in many standard sizes to meet the toughest service demands. Without cost or obligation, Hoffman engineers will provide objective recommendations on units to help reduce costs and boost profits in your plant. Send now for free brochure AB 104.

U.S. Hoffman Machinery Corp.
Air Appliance Division
103 Fourth Avenue
New York, New York

Occasional greasing was only servicing required in 22 years continuous operation.



For more data on advertised products, use Readers' Service Cards, last page.



Building . . .

engineer and operate the plant, in which Gulf Interstate will receive a percentage of the net profits after pay-out.

Union Carbide Corp. plans to build a 26.5-million-pound-per-year ethylene oxide unit adjacent to its Celene, Italy, polyethylene plant currently under construction. The plant, to be completed in 1960, is owned jointly with Societa Edison.

Petroleos Mexicanos will construct two Platforming and three Unifining units, a Udex unit for benzene, toluene and xylene manufacture, and a Hydrar unit for cyclohexane production. Design and construction will begin immediately. Auxiliary equipment and other petrochemical facilities for agricultural chemicals will also be installed at Minatitlan and other locations in Mexico. Basic engineering will be done by Universal Oil Products Co. while detailed engineering and procurement will be handled by Fluor Corp. Petroleos Mexicanos will handle actual construction.

Aziende Colori Nazionale Affini has contracted with Badger Manufacturing Co. for construction of a 10,000-metric-ton-per-year phthalic anhydride plant at Milan, Italy. Engineering of the plant will be completed in July. Construction of the unit, which employs a fluid bed catalytic process, will be finished in late 1959.

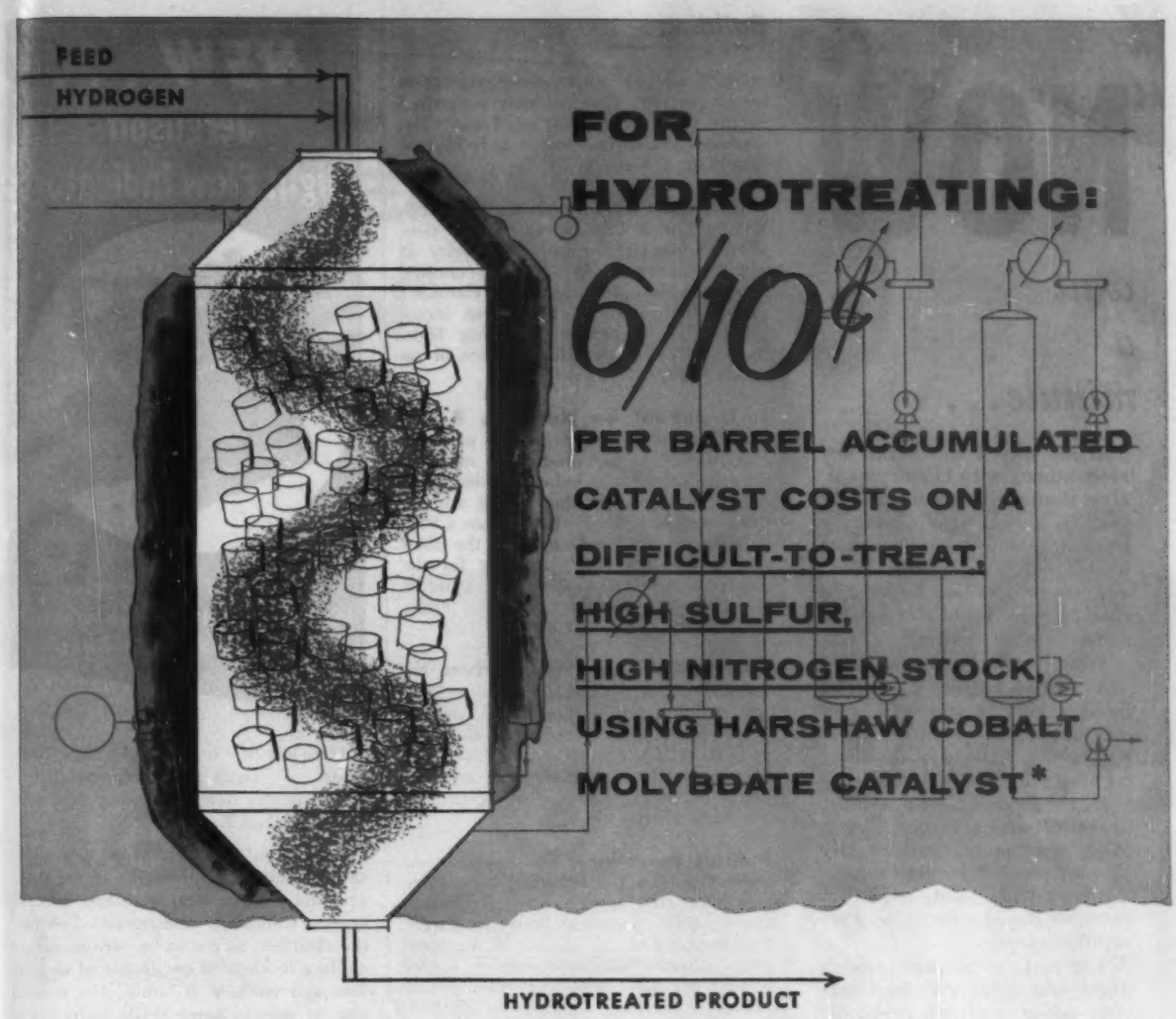
The Dow Chemical Co. has doubled its polyethylene capacity for the second time in a year with completion of a new production plant at Freeport, Texas. Expansion to double the original capacity was completed last fall. First material from the new plant was reported a little more than a year after work on site development began. Dow is also building plants at Plaquemine, La., and Bay City, Mich.

Standard Vacuum Oil Co. has been named by the Indonesian government to develop gas resources in a South Sumatra field. The gas would be delivered to a proposed government-owned urea fertilizer plant near Palembang. Capacity would be 100,000 tons per year. Stanvac will build a 60-mile pipe line to deliver 5-billion cubic feet per year to the plant for 20 years.

Deurag-Nerag's Misburg refinery, near Hanover, plans to install a combination delayed coking, thermal cracking and crude unit sometime this year. Engineered by The Lummus Co., the plant will go on stream in 1960. The 21,000-bpd facility will produce up to 50 percent diesel distillate and as little as 20 percent gasoline and fuel oil.

Union Carbide Corp. is upping capacity of its Whiting, Ind., low-density polyethylene plant 410 million pounds per year. The increase will take effect this summer with completion of an 80-million-pound expansion. The firm is said to be shooting at inexpensive capacity to

Specialists
IN TANK AND VESSEL—
Fabrication
Design, Fabrication, Erection, Testing and Repairs
Tanks and vessels—from the first preliminary design to the finished job, completely tested and ready for service—are our exclusive interest. We have no other departments. Every thought is given to producing the very best tank or vessel possible. Next time, let us figure your requirements—whether it's one tank or a hundred-plus tank farm installation.
Erection
ELLERBEE BROTHERS
X-Ray Testing
P. O. BOX 857
PORT ARTHUR, TEXAS



Consistently low catalyst costs for hydrotreating, using Harshaw Cobalt Molybdate Catalyst, are possible because the inherent ruggedness and high thermal stability of our catalyst permits repeated regenerations while maintaining full activity—in one instance *223* regeneration cycles without loss in activity.

This versatile Harshaw catalyst performs efficiently over a wide range of feedstocks—from low boiling naphthas to heavy coker distillates. In all applications, the long life of our catalyst reflects reduced per-barrel costs.

For further information contact the Harshaw Branch nearest you. Our representative will be happy to discuss with you the application of Harshaw Cobalt Molybdate Catalyst to your operation.

*Based on an actual customer experience to date in a specific unit still operating. Its continuing operation will further reduce the 6/10¢ per barrel cost.

HARSHAW

THE HARSHAW CHEMICAL CO.
1945 E. 97th STREET • CLEVELAND 6, OHIO

CHICAGO
CINCINNATI
CLEVELAND
DETROIT
HASTINGS-ON-HUDSON
HOUSTON
LOS ANGELES
PHILADELPHIA
PITTSBURGH

For more data on advertised products, use Readers' Service Cards, last page.

"NOW

wait

a

minute . . .

Tell me why I can make any more money with Houdry's catalyst than with someone else's?"

Quite a challenge . . . coming from a chemical engineer who knows plant operations inside out. As prospective buyer of a catalyst, you'd probably ask the same question, yourself.

Well, here's the answer.

You may require a catalyst for any one of a number of specific processes. No matter where you buy it, its composition may be pretty much the same.

But composition does not prove its earning power. This is something that can be done only in your process, in your equipment, in your plant. And that is where the experience of your supplier counts.

You make a maximum return when your supplier understands your needs, and can make his catalyst deliver accordingly. Because we are process designers, creators of catalysts and catalytic processes, this is a job HOUDRY people know well.

When you buy catalyst from HOUDRY, you're buying all the benefits of pioneering experience in catalysis. Why not tell us your requirements, and let us give you a more detailed description of how we can serve you.

*

HOUDRY

CATALYSTS

HOUDRY PROCESS CORPORATION

1528 Walnut Street, Philadelphia 2, Pa.

*Houdry means Progress . . . through Catalysis

Building . . .

boost its over-all polyethylene production by 40 percent. The first unit authorized in the move is a plant at Texas City. Carbide is also building a polyethylene film plant at Cartersville, Ga.

Union Carbide Chemicals Co., division of Union Carbide Corp., has doubled its polyether polyol capacity at South Charleston, W. Va. An unusual feature of the unit is that *all* of Carbide's process improvements have been incorporated in its design, providing high-purity polyols with a high degree of reproducibility.

E. I. duPont de Nemours & Co. plans to build a $20-million plant in Florence, S.C., for production of polyester packaging and industrial film. Construction will begin this month and be completed in 1961. To be built on a 954-acre site on the Pee Dee River, the plant will double Du Pont's capacity for the material. A similar Du Pont plant is under construction at Circleville, Ohio, and will be completed early in 1960.

Societe Chimique des Derives du Petrole, S.A. and Union Carbide, Ltd., plan to build a 30-million-pound-per-year polyethylene plant at Antwerp, Belgium. It is slated for completion in 1960. The firm recently completed an ethylene oxide plant at Antwerp, designed by Scientific Design Co.

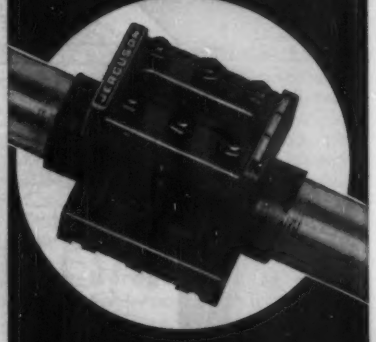
Phillips Petroleum Co. has assumed control of two Canadian refineries, one at Taylor, B.C. and the other at Dawson Creek, B.C., previously run by Pacific Petroleums, Ltd., its partner in the operation. Phillips also took over a Taylor natural gas plant. Pacific Petroleum will pursue exploration activities in British Columbia. The firms plan to expand the two refineries to produce a full line of petroleum products.

Union Carbide Ltd.'s Grangemouth, Scotland, polyethylene facilities will be doubled with installation of a new 30-million pound-per-year unit. It will be completed in 1960. Carbide is constructing an ethylene oxide and derivitives plant at Fawley, England, which will go on stream late this year. The Grangemouth plant will double Carbide's United Kingdom polyethylene capacity.

Use Readers' Service Postcard on page 317 for more information on advertised products

NEW . . .

Jerguson Sight Flow Indicators



easily and inexpensively installed to show movement of liquid in pipe lines

Here is a new line of Sight Flow Indicators . . . easily and inexpensively installed in any new or existing pipe line ½" to 2" N.P.T.

The special design of these new indicators results in a turbulence in the flow of liquid, making it easily visible. Several types of indicating vanes, installed within the chamber, may also be furnished, according to variable conditions of rate of flow and viscosity of liquid. For indication of minute flows, small Sight Flow Indicators with a rotating vertical rising ball are available.

Jerguson Sight Flow Indicators are soundly designed, carefully made, and are backed up by a company with over 40 years experience in the field. Available in Transparent and Reflex types, in a wide variety of materials and linings, and with Wedge Type Illuminators, Haveg Chambers, Non-Frosting Glasses, or other special construction.

If you have a problem of viewing the flow of liquid in a pipe line, it will pay you to investigate the new Jerguson Sight Flow Indicators today. Send us your requirements or write for Data Unit.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

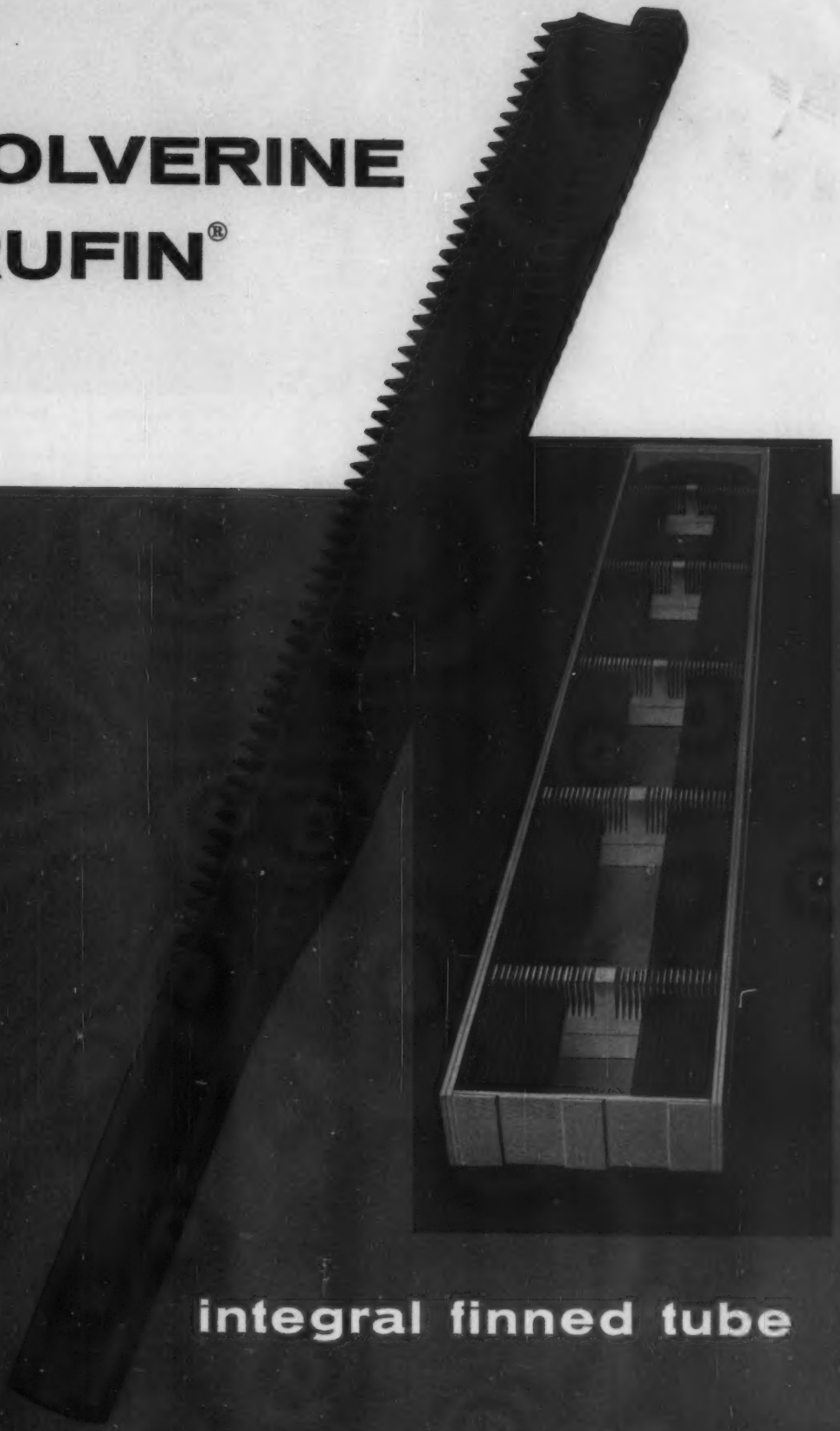
JERGUSON GAGE & VALVE COMPANY

100 Adams Street, Burlington, Mass.

Offices in Major Cities

Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

WOLVERINE TRUFIN®



the integral finned tube

when EXPERIENCE counts

—you can count on

WOLVERINE TUBE

Wolverine Tube developed integrally finned tubing (Wolverine Trufin) in 1928 and since that time has been the originator of most of the available information on finned tube technology.

Wolverine research has uncovered the most advantageous applications of Trufin and has developed the various types of integrally finned tube on the market today.

For the past several years, throughout the country's major processing and refining areas, Wolverine has conducted a series of Technical Heat Transfer Seminars under the guidance of the top men in this field.

Wolverine Tube has also given special and extensive heat transfer and integrally-finned tube training to a number of Technical Sales Representatives who operate on a national basis. The services of these men are available to the heat transfer industry at large. Those desiring specific finned-tube knowledge can also draw on Wolverine's large library of product literature and catalogs.

There is an American business maxim that says *"For qualified guidance you must seek a qualified source."*

You'll find that where integrally-finned tubing is concerned Wolverine Tube is indeed such a source.

WOLVERINE ALLOY CODE

CODE NO.	ALLOY	WT./FT. CONVERSION FACTOR (Wt./Ft. of Copper x Conv. Factor = Wt./Ft. of alloy)
01	Copper	1
25	Admiralty (Type C)	.9531
26	Admiralty (Types B & D)	.9531
28	85/15 Red Brass	.9780
30	Aluminum Brass (Type B)	.9319
40	1100 Aluminum	.3032
41	3003 Aluminum	.3065
50	Nickel	1
51	70/30 Cupro-Nickel	1
53	90/10 Cupro-Nickel	1
54	Monel	1
60	Low Carbon Steel	.8761
70	Stainless Steel	.8978

Example: *Wolverine Trufin type S/T*
Catalog No. 60-195065-26

60	19	5	065	26
TYPE S/T	FINS PER INCH	ROOT DIA. IN 1/8 OF INCH	WALL AT FIN	ALLOY

TRUFIN TYPE H/A

19 FINS PER INCH

NOMINAL SIZE O.D.	CATALOG NO.	PLAIN SECTION DIMENSIONS O.D.	Wall Thk.	Root Dia.
5/8	60-194028 60-194035 60-194042 60-194049 60-194065	.625	.042 .049 .058 .065 .083	.500
3/4	60-195028* 60-195035 60-195042 60-195049 60-195065 60-195083	.750	.049 .052 .058 .065 .083 .095	.625
7/8	60-196035* 60-196042 60-196049 60-196065 60-196083	.875	.054 .058 .065 .083 .095	.750
1	60-197042 60-197049 60-197065 60-197083	1.000	.058 .065 .083 .095	.875

*Plain la
195028
condition

TRUFIN TYPE L/C—BIMETAL

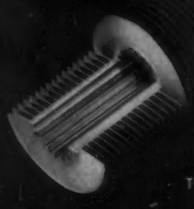
TRUFIN TYPE H/R

TRUFIN TYPE S/T

TRUFIN TYPE S/T—DUPLEX

CTION ONS	FINNED SECTION DIMENSIONS				OUTSIDE AREA	SURFACE AREA RATIO	I.D. CROSS SECTIONAL AREA In Sq. Inches	APPROX. WT./FT. LBS. (Copper)	AVAILABLE ALLOYS (See Attached Code)
Wall Thk.	Root Dia.	Wall Thk.	Inside Dia.	d_o	Sq. Ft. per Linear Ft.	a_o/a_i			
.042	.500	.028	.444	.535	.405	3.48	.155	.283	
.049		.035	.430			3.60	.145	.320	01, 53, 40, 41, 50
.058		.042	.416			3.72	.136	.356	
.065		.049	.402			3.85	.127	.391	01, 53, 51, 40, 41,
.083		.065	.370			4.18	.108	.466	50, 28, 25, 26, 60
.049	.625	.028	.569	.660	.496	3.33	.254	.353	
.052		.035	.555			3.41	.242	.401	01, 53, 40, 41, 50
.058		.042	.541			3.50	.230	.448	
.065		.049	.527			3.60	.218	.493	
.083		.065	.495			3.84	.192	.593	01, 53, 51, 40, 41,
.095		.083	.459			4.13	.166	.697	50, 28, 25, 26, 60
.054	.750	.035	.680	.785	.588	3.30	.363	.485	
.058		.042	.666			3.37	.349	.541	01, 53, 40, 41, 50
.065		.049	.652			3.44	.334	.597	
.083		.065	.620			3.62	.302	.721	01, 53, 51, 40, 41,
.095		.083	.584			3.85	.268	.853	50, 28, 25, 26, 60
.058	.875	.042	.791	.910	.678	3.27	.492	.632	
.065		.049	.777			3.33	.474	.699	01, 53, 40, 41, 50
.083		.065	.745			3.48	.436	.847	01, 53, 51, 40, 41,
.095		.083	.709			3.65	.395	1.006	50, 28, 25, 26, 60

Plain lands are available on all standard Type S/T sizes except 195028 and 196035. All lands are supplied in the annealed condition. They are limited to a minimum length of one inch.



TRUFIN TYPE I/L

TRUFIN TYPE S/T
U-BEND FOR SHELL AND TUBE CONDENSERS

NEED HELP WITH HEAT EXCHANGER PROBLEMS?

Let These Specialists Serve You

Each of these men is a highly-trained specialist in the field of heat transfer. If you have a problem concerning such things as design, corrosion, alloy selection, where and when to use integrally-finned tube, etc.—don't hesitate—give the one nearest you a call. You can depend fully on his heat transfer knowledge.

WOLVERINE TUBE

17200 Southfield Road
Allen Park, Michigan

Wolverine Tecfin is available in Canada through the Unifin Tube Division, London, Ontario, Canada.

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

Building . . .

presented a challenging problem to Tidewater engineers. The gas is almost 15 percent hydrogen sulfide by volume, and highly corrosive. In the gas charge, the distillate runs about 180 barrels per MMcf of gas. Thus the daily output, in addition to sulfur, will be 7,480 bpd of distillate, 1,040 bpd of propane and 550 bpd of butane.

Tidewater and Texaco, Inc., each have a 46 percent working interest in the New Hope field. Humble Oil & Refining Co. has four percent, with the remaining four percent split among several holders.

Hungarian Government is planning to build two 20,000-bpd refineries, one at Szoeny, near Komom, and the other at Szazhalombatta, south of Budapest. The latter will include a lube plant and will process crude from a projected USSR-East Europe pipe line. The government also says that Hungary's crude output goal of 22,000-bpd set for 1960 has been revised to this year's goal.

Petroleo Brasileiro is expanding its Mataripe refinery from 10,000 bpd to 42,000. Work, currently is ahead of schedule, is set for completion in August. The plant will be able to process Bahia crude into lube oils and paraffin.

Signal Oil & Gas Co. has completed engineering work on $40-million, 40,000-bpd refinery to be built either at Huntington Beach, Calif., or at the site of Hancock Oil Refining Co.'s burned-out Long Beach refinery. Also, construction is to begin shortly at Signal's Bankline refinery, Bakersfield, to increase capacity from 8,,000 bpd to 15,000. Plans call for use at Bakersfield of some undamaged cracking equipment from the Hancock refinery.

Montecatini Co. is reportedly planning to construct its first U.S. plant for the manufacture of isotactic polypropylene and other petrochemicals. To be built at Neal, W. Va., construction will begin this year. The firm has filed a registration statement with the Securities Exchange Commission for $10 million worth of sinking fund debentures and warrants to buy capital shares of the company. The proposed plant would have an 11-million-pound-per-year capacity.

Quaker State Oil Refining Co. is expanding its Farmers Valley, Pa., refinery. The company says the move is being made because of increased foreign demand for wax, correlated with closeness of the plant to the sea. The $400,000 construction job will up output about 18 percent.

Societe Coautchouc Butyl has gone on stream at Port Jerome, France, with what is reportedly Europe's first Butyl rubber plant. The 20,000-ton-per-year plant was engineered by Compagnia Technica Industrie Petroli and C F Braun & Co. It will market 50 percent of its products in France and the remainder in the rest of Western Europe.

For reciprocating pumps

MORE PUMP CAPACITY ...AT LESS PUMP SPEED with Royal Crown PUMP VALVES

Round valve surface is streamlined. No crossbars or obstructions in seat to restrict the flow of liquid.

Ball-guided valve rotates and swings with each stroke of the pump. Each turn, each swing a lapping action — a continuing perfect seat.

Free vertical action assures instant opening and closing. Ball stem is a frictionless guide.

It's a fact. This revolutionary valve increases pump volume with *less pump speed!* Here's how the Royal Crown Valve operates: Valve is guided by a frictionless ball stem (not a rigid guide) which allows it to oscillate and turn freely with the fluid stream with a minimum of resistance. This means you can pump a greater volume at a slower pump speed for maximum pump efficiency and economy. Royal Crown Valves have only three separate parts which assures long, trouble-free service. They are adaptable to all reciprocating pumps and all liquids.

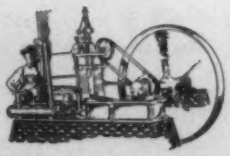
The Pump Valve with 1000 Seats

EACH TURN
EACH SWING
A PERFECT SEAT

Write for literature and engineering data.

MADSEN WORKS / BALDWIN-LIMA-HAMILTON CORPORATION
CONSTRUCTION EQUIPMENT DIVISION

14120 E. ROSECRANS AVE., P.O. BOX 38, LA MIRADA, CALIFORNIA
BALDWIN-LIMA-HAMILTON CORPORATION, LIMA, OHIO



1856 Frick Steam Engine

TRADE FRICK MARK

350-Ton Compressor, of 1896

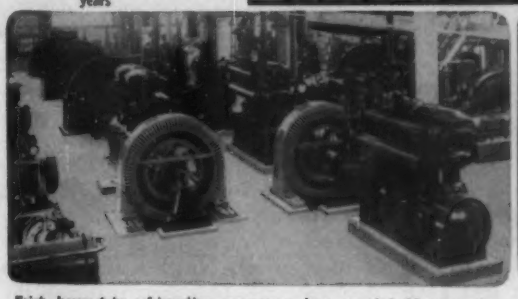
ONE NAME, *One Independent Company, One Standard of Excellence Since 1853*

We're decidedly in business at the old stand, under the same experienced management as heretofore, and welcome the chance to serve both old and new customers. Let us quote on your air conditioning, refrigerating or ice-making needs: write . . .

Steam-driven compressor in service at Peoria, Ill., 60 years

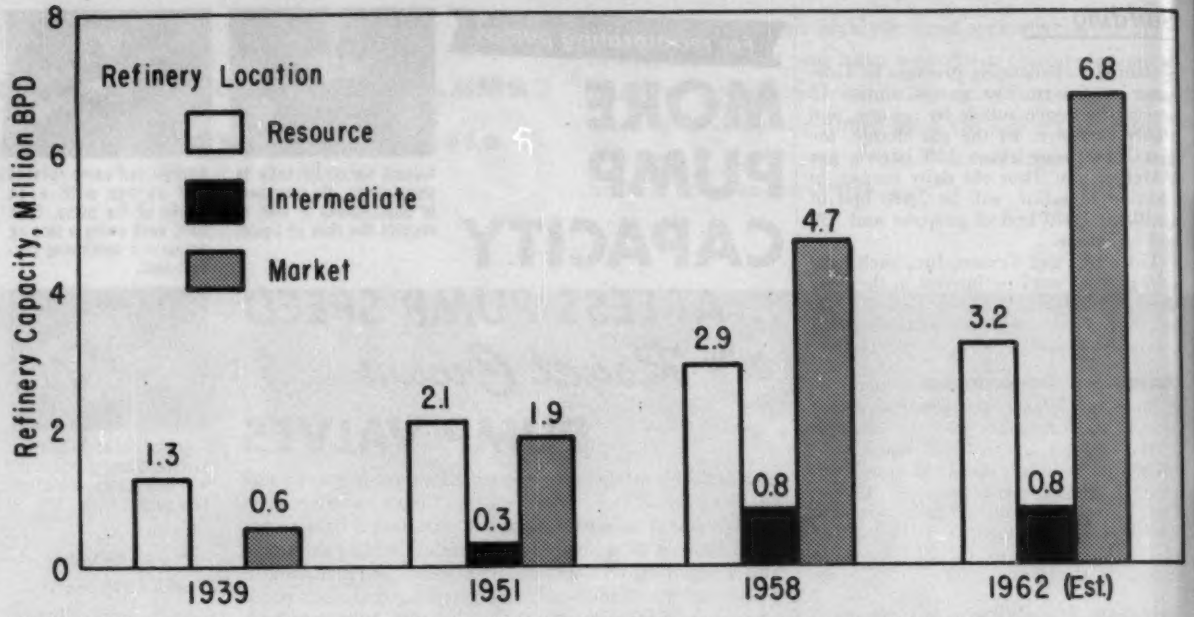
Enclosed compressors, introduced 1915, have useful life of 40 years

WAYNESBORO, PENNA. U.S.A.
FRICK CO.



Frick heavy-duty refrigerating compressors have operated 30 years at Celanese Corp., Amcelle, Md.

"ECLIPSE" machines handle any refrigerant at any temperature.



World refining capacity, excluding U.S., Canada, U.S.S.R., Eastern Europe and China, is shifting away from resource areas.

"Construction Boxscore" data reveal . . .

Now New Refineries Are Nearer Market

Refineries outside North America and the Soviet sphere are more concentrated now in marketing areas than in areas near the petroleum resources. Many factors influence the economics of refinery location. Among them are plant size, refinery yield pattern, demand pattern, transportation costs and political considerations. Here is a summary of some aspects in the interrelation of size and location.

World refining capacities outside North America, U.S.S.R., Eastern Europe and China in 1939, 1951 and 1958 are shown in Figure 1. The year 1951 is reported as the mid-point of post-war refining construction. These data are broken down into geographic areas in Table 1.

Resource refineries primarily convert crude oil, at or near the oil field, into petroleum products for shipment to distant markets. Local demands are met but these are usually too small to have much influence on the over-all picture. But there are instances where local market demand has risen so rapidly that refineries in that area have ceased to be resource (export) refineries, and have become market refineries. Burma and Mexico are examples.

Market refineries are plants at or near the centers of consumption, and located to serve a particular area. In the U.S. and in other areas such as Rumania, Western Germany, Austria and Poland, there are landlocked oil fields where local consumption also exists. Then the refineries actually in or near oil fields distribute their products locally. They are, in terms of this report, market oriented.

Intermediate refineries are plants built between one or more sources of crude oil supplies and a number of markets. This is to provide flexibility both for the sources of supply and the markets. Most of these intermediate refineries, while serving more-or-less distant markets, have some local market to supply (in the case of the Canary Islands and Aden it is a substantial bunker business). Also in the intermediate category fall, to varying degrees, refineries such as those at Augusta (Sicily), Naples and Pernis (Rotterdam), plus some plants in the U.K., in Southern France and in Australia. Quantities of petroleum products exported from a country were used to estimate the part of refinery capacity working for the local market, and that working for markets that need onward transportation. This cannot be altogether accurate, but it shows the size of capacity which would fall into the intermediate class.

An increase in capacity of more than four times is shown for refineries in the selected areas between 1939 and 1958. Of this total growth, the capacity of resource refineries is a little more than double what it was, while market refineries have increased eight times and the intermediates have risen from nil to more than nine percent of the current total.

The last column of Table 1 covers estimated capacity in 1962. It shows a trend toward yet more market-oriented refineries.

Demand structure of a market can have a great influence on a market-oriented refinery. Such a refinery can supply more distant areas of consumption only by way of crosshauls or even backhauls. This involves transport more costly than if the supplies

areas.

et

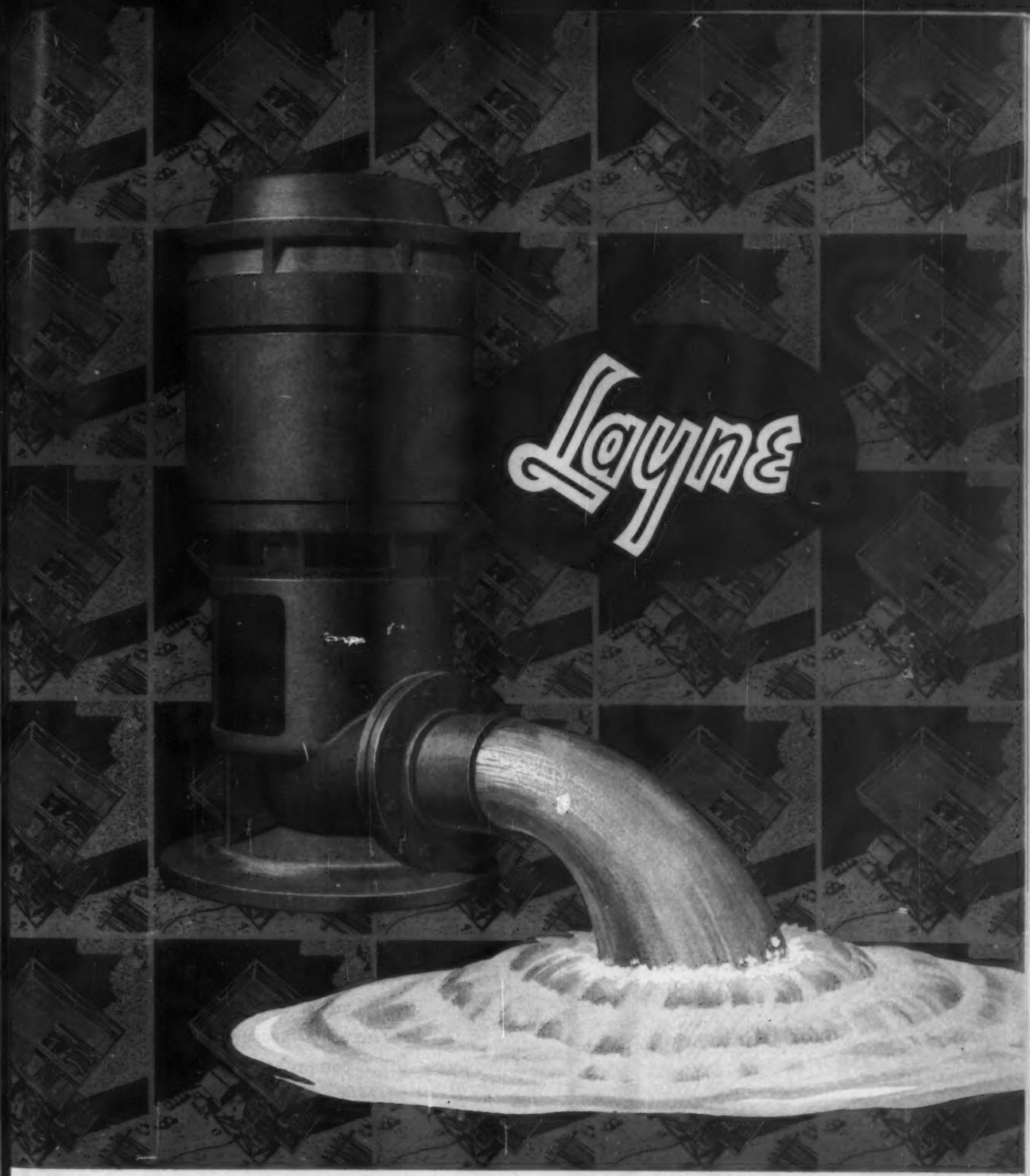
ducts
ed to
pacity
l that
ward
alto-
e size
o the

more
neries
9 and
apac-
little
while
eight
risen
ercent

covers
shows
arket-

t can
arket-
y can
con-
uls or
trans-
pplies

No. 7



Layne pumps top more producing water wells

Layne Pump Design, manufacture and installation are only part of the complete water service offered by the Layne organization. Other services include: Initial surveys, explorations, recommendations, site selection, foundation and soil sampling, well drilling, well casings and screens, gravel wall wells, construction of water systems, complete research staff and facilities, maintenance and service, chemical treatment of water wells, water treatment. *Write for Bulletin No. 100.*

WORLD'S LARGEST Layne WATER DEVELOPERS

LAYNE & BOWLER, INC., MEMPHIS

Offices and Factory • Memphis 8, Tennessee

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

pH under pressure...high or low pressure, hydrostatic head...Beckman Reference Electrodes are the very heart of superior pH measuring systems *under pressure extremes.* ⊠ Pressurized reference electrodes open new areas of pH control...in process streams up to 100 psi ...at temperatures up to 212° F...where only hydrostatic pressure is required... for accurate measurements from 0 to 14 pH. A comprehensive line of mountings offers a variety of pH system installations. ⊠ Beckman pH accessories, meters and electrodes are available through leading recorder companies. For detailed information write for Data File P-7-25.

Beckman
Scientific and Process Instruments Division
Beckman Instruments, Inc.
2500 Fullerton Road,
Fullerton, California

It's a Fact: Three separate plug-in components in the Model W Industrial pH Meter allow easy, quick maintenance, even by untrained personnel.

TABLE 1—World Refining Capacity
(Excludes U.S.A., Canada, U.S.S.R., Eastern Europe and China)
REFINING CAPACITY, THOUSANDS OF BARRELS PER DAY

Area	Resource Refineries				Intermediate Refineries				Market Refineries				Total			
	1939	1951	1958	1962 (Est.)	1939	1951	1958	1962 (Est.)	1939	1951	1958	1962 (Est.)	1939	1951	1958	1962 (Est.)
Europe	....	....	....	....	....	279	668	700	367	1,112	2,614	3,805	367	1,391	3,282	4,505
Africa	....	....	....	....	....	....	20	20	14	68	152	272	14	68	172	292
Middle East	340	867	1,031	1,061	....	....	60	50	7	71	151	188	347	938	1,242	1,299
Far East	156	205	293	293	....	....	....	....	42	96	663	981	198	301	956	1,274
Australia	....	....	....	....	....	....	20	10	4	21	186	231	4	21	206	241
Caribbean	806	1,061	1,583	1,836	....	....	....	....	....	236	404	561	806	1,297	1,987	2,397
S. America	....	....	....	....	....	....	....	....	129	272	543	806	129	272	543	806
Total	1,302	2,133	2,907	3,190	....	279	768	780	563	1,876	4,713	6,844	1,856	4,288	8,388	10,814
% of Total	69.8	49.7	34.6	29.5	....	6.5	9.2	7.2	30.2	43.8	56.2	63.3	100.0	100.0	100.0	100.0

were organized in a "straight line" between the resource and those other markets. Thus it is imperative to build such refineries in areas where the demand pattern for the several main products is in line with the yield pattern of a technically and economically viable refinery.

Transportation is another important factor in deciding where to locate a refinery. In favor of resource refineries is the fact that to transform crude oil into products one has to use some of it as refinery fuel, and losses are bound to result. Depending on the type of refinery, the two together involve five to ten percent of crude input. The fact that no (or little) freight is involved if the crude is processed at or near the source results in these losses, and the refinery fuel being less costly than if the whole-crude had to be carried to distant refineries. An exception would be a case where there is a more economic fuel such as natural gas available to the refinery locally.

A point in favor of near-the-market refineries lies in the relation of crude transportation costs (to a refinery) and distributing products (from the refinery). Since the early days of the oil industry, shipping of crude has been cheaper than that of most petroleum products, because tanker freight is lower for "dirty" than for "clean" cargoes. This was because of cleaning costs, the need for a clean tanker, and the higher degree of corrosion involved in carrying white products.

An inverse move pushing refineries back to a point nearer the resource and away from the markets would be the introduction of products pipelines in Europe. Today, there is in operation only one for non-military use, that from the lower Seine refineries to Paris. But there are plans for others.

Political considerations must be made. The desire to create a *national* industry plays a big role in locating refineries. These political elements may no longer express themselves in the form of discriminatory legislation or straight customs protection. Nevertheless, a nation must save foreign exchange by having refineries within its borders so it can draw on different crude sources. This is a safeguard to international politics and trade negotiations.

Thus a combination of technical and political considerations has shifted the general preference away from the resource-oriented location, although the situation is still in a state of flux.

Exerpted from a paper entitled "Current Economic Trends in Location and Size of Refineries in Europe," by P. H. Frankel and W. L. Newton, Petroleum Economics, Ltd., London, as presented before the Fifth World Petroleum Congress, New York City, June, 1959.

Construction Boxscore

Oil, Gas and Petrochemical Processing Plants

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Allied Chemical & Dye	Buffalo, N.Y.	Polyethylene	.....	.....	Under Constr	.....	.....	.....	.....
American Cyanamid	Bridgeville, Pa.	Maleic Anhydride	14,000,000 lbs/yr	.....	Under Constr	Late 1959	S D	S D	S D
	Bound Brook, N.J.	*Anthraquinone	4,000,000 lbs/yr	.....	Under Constr	.....	.....	.....	Foster Wheeler
		Naphthoquinone	1,000,000 lbs/yr	.....	Under Constr	.....	.....	.....	Foster Wheeler
		Phthalic Anhydride	7,000,000 lbs/yr	.....	Under Constr	.....	.....	.....	Foster Wheeler
Ashland O & R	Catlettsburg, Ky.	*Aliphatic Solvents	.....	.....	Under Constr	1959	.....	Procon	Procon
Atlantic Refining	Philadelphia	Vacuum Flash	40,000 bbls	.....	Complete	.....	.....	Hydrocarbon	Hydrocarbo
		*Dewaxer-Deoiler	10,800 bbls	$11,500,000	Complete	Mid 1959	Texaco	Badger Mfg	Badger Mfg
		Revamp Visbreaker	20,000 bbls	.....	Under Constr	.....	.....	Atlantic	Atlantic
		*MEK Dewaxing and Deoiling	11,000 bbls	$11,500,000	Complete	.....	Texaco	Badger Mfg	Badger Mfg
Coastal Chemical	Pascogula, Miss.	Ammonia	200 tons	$6,650,000	Complete	.....	.....	Chemico	Chemico
Columbia Hydrocarbon	Siloam, Ky.	Hydrocarbon Fractionation with pipe line and offsite facilities	230,000,000 gal/yr	$5,000,000	Complete	.....	.....	Pritchard	Pritchard
Commerce Oil Ref.	Jamestown, R.I.	Refinery: Crude Distl.	40,000 bbls	$50,000,000	Engineering	.....	UOP	Fluor	Fluor
		Cat Cracking	25,000 bbls						
Du Pont	Belle Works, W. Va.	Urea; Ammonia Methyl Methacrylate, Nylon Intermediates	.....	.....	Planned	1959	Texaco	.....	.....
	New Jersey	Hydrogen	.....	.....	Engineering	.....	.....	Chemico	Chemico
Esso Standard	Bayway, N.J.	*Exp. Cat Cracker Light Ends	.....	.....	Under Constr	Early 1960	.....	.....	.....
Grace Chemical Div., W.R. Grace	Memphis	*Exp. Urea	300 tons	.....	Under Constr	.....	.....	Foster Wheeler	.....
Gulf Oil	Near Charleston, S.C.	Refinery	.....	.....	Planning	.....	.....	.....	.....

Construction BOXSCORE Continued on Page 220

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Hess	Perth Amboy, N.J.	Unifiner-Platformer	5,000 bbls	.....	Complete	.....	.....	.....	.....
		No. 2 Fuel Oil Unifiner	5,000 bbls	$1,500,000	Complete	.....	UOP	Treco	Treco
Mississippi Chem.	Pascagoula, Miss	*Urea	100 tons	.....	UnderConstr	1959	Inventor Uhde	Vulcan	Vulcan
	Yazoo City, Miss.	*Urea	100 tons	.....	Under Constr	Mid 1959	Inventa Vulcan	Vulcan	Vulcan
	Elizabeth, N.J.	*Maleic-Anhydride	20,000,000 lbs/yr	$4,000,000	Engineering	June 1960	Badger Mfg.	Badger Mfg.	Badger Mfg.
Reichhold Chemicals	Hampton, S.C.	Formaldehyde	30,000,000 lbs/yr	.....	Engineering	.....	.....	.....	.....
	Tuscaloosa	Formaldehyde	35,000,000 lbs/yr	.....	Planning	.....	Staff	Staff	Staff
Shell Oil	Little Creek, Miss.	*Nat. Gas Liquids	5-MMcf	.....	Planning	.....	.....	.....	.....
Sinclair	Marcus Hook	*Hydrodesulfuriser	20,000 bbls	.....	Engineering	Late 1959	.....	Catalytic	Catalytic
Sun Oil	Marcus Hook, Pa	*Furnace Oil sifuriser	15,000 bbls	$1,257,000	Under Constr	Fall 1959	.....	Staff	Sun Oil
		*Propylene Fractionating Facilities	.....	$1,065,000	Under Constr	Fall 1959	.....	Staff	Staff, others
		*Exp & Modernize Grease Plant Facilities	.....	$400,000	Under Constr	Summer 1959	.....	Staff	Staff
		*Exp. Wax Moulding and Packaging	.....	$637,000	Under Constr	Summer 1959	.....	Staff	Staff
		*Automatic Tank Gauging System	.....	$255,000	Under Constr	Spring 1960	.....	Staff	Staff
		*Product Control Center Combination Refinery Unit	.....	$100,000	Under Constr	Continuous Develop Work	.....	Staff	Staff
		*Chassis Dynamometer Addition	.....	$352,000	Under Constr	Summer 1959	.....	Staff	Staff, others
		*Automatic Crude Blending	.....	$230,000	Under Constr	Fall 1959	.....	Staff	Staff
SunOlin Chem.	North Claymont, Del.	*Urea	200 tons	$8,000,000	Under Constr	Early 1960	.....	Kellogg/Staff	Kellogg
Union Carbide Chemicals	Institute, W. V.	Exp. Acrylonitrile	.....	.....	.....	.....	.....	.....	.....
		*Epoxies	10,000,000 lbs/yr	.....	Under Constr	1959	.....	.....	.....
	Winfield, W.V.	Petrochemical	.....	.....	Complete	.....	.....	.....	.....
United Refining	Warren, Pa.	Crude Distl.	15,000 bbls	.....	Complete	.....	.....	Staff	Staff
		Cat Reformer Revamp	4,000 bbls						
		Depentanizer	5,000 bbls						
		Cat Cracker Revamp	5,000 bbls						

Mid-Continent

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Aurora Gasoline	Detroit	Vacuum Distl.	18,000 bbls	.....	Under Constr	1959	.....	Treco	Treco
		*Alkylation	2,000 bbls	.....	Engineering	Late 1959	.....	Treco	Treco
Bay Refining	Bay City, Mich.	Crude Distl.	12,000 bbls	$900,000	Under Constr	Mid 1959	.....	Sweco	Sweco
		Alkylation	850 bbls	$850,000	Under Constr	Mid 1959	UOP	Sweco	Sweco
Callery Chemical	Muskogee, Okla.	Hydrogen	800,000 scf	.....	.....	.....	.....	.....	.....
		Carbon Dioxide	7,790 lbs hr	.....	.....	.....	.....	.....	.....
Cooperative Farm Chemicals	Lawrence, Kan.	Ammonia Urea	100 tons/30 tons	$5,400,000	Under Constr	August 1959	.....	Chemico	Chemico
Derby Refining	Wichita, Kan.	Alkylation	1,700 bbls	$1,500,000	Under Constr	1959	.....	Procon	Procon
		Waste Disposal, Cooling Tower, LPG Storage	.....	$405,000	Under Constr	1959	.....	Litwin	Kaichin Hughes/Litwin/ Staff
Dow Chemical	Bay City, Mich.	Petrochemical	.....	.....	Under Constr	Summer 1959	.....	Bechtel	Austin
		Polyethylene	.....	.....	Under Constr	Summer 1959	Zeigler	Bechtel	Bechtel
DX Sunray	Duncan, Okla.	*Cat Cracker Revamp	.....	$600,000	.....	.....	.....	.....	Treco
Goodyear Tire & Rubber	Point Pleasant, W. Va.	Polyester Resin	.....	$10,000,000	Planning	.....	.....	.....	.....
Grace Chemical Div. W. R. Grace	Memphis, Tenn.	Exp. Urea	300 tons	.....	Under Constr	1959	.....	Foster Wheeler	Process Contracting
Gulf Oil	Toledo	Alkylation	2,000 bbls	.....	Complete	.....	.....	Kellogg	Kellogg
	Cleves, Ohio	*Hydrobon	11,000 bbls	.....	Engineering	1960	UOP	McKee	McKee
Kerr-McGee	Wynnewood, Okla	*Exp Crude	25,000 bbls	.....	Under Constr	Jan 1960	.....	Litwin	Staff
		*Vacuum Distl	10,625 bbls	.....	Under Constr	Jan 1960	.....	Litwin	.....
		*FCCU Revamp, TEL	.....	.....	Under Constr	Jan 1960	.....	Litwin	.....
Lion Oil	El Dorado, Ark.	Unifiner—Platformer	5,000 bbls	$1,600,000	Engineering	.....	UOP	UOP/Procon	Procon
		*Tetramer	340 bbls	.....	Under Constr	Oct. 1959	UOP	Procon	Procon
		*Solvent Deasphalting	5 260 bbls	$1,000,000	Complete	.....	.....	Badger Mfg	Badger Mag
		*Exp Refinery	4,000 bbls	.....	Under Constr	Oct 1959	.....	.....	Lion
Monsanto Chemical	Monsanto, Ill.	Phenol Exp.	.....	.....	.....	.....	.....	.....	.....
	El Dorado, Ark.	Urea Distl.	.....	.....	Under Constr	.....	.....	Chemico	Chemico
Northwestern Ref.	St. Paul Park, Minn.	Cat Reformer	.....	.....	Planning	1959	.....	.....	.....
Phillips Pet.	Kansas City, Kan.	*Alkylation	6,000 bbls	.....	Under Constr	1960	Phillips	Phillips	Procon
Reichhold Chemicals	Detroit	Formaldehyde	35,000,000 lbs/yr	.....	Planning	.....	Staff	Staff	Staff
	Kansas City, Kan.	Formaldehyde	35,000,000 lbs/yr	$500,000	.....	.....	.....	.....	.....
R & J Oil & Ref.	Princeton, Ind.	Unifiner	1,700 bbls.	.....	Planning	.....	.....	.....	.....
		Crude Distl.	5,000 bbls	.....	Under Constr	1959	.....	.....	.....
		Platformer	1,700 bbls	.....	Planning	.....	.....	.....	.....
Shell Oil	Wood River, Ill.	Exp. Lube Oil	4,000 bbls	.....	Engineering	Mid 1959	.....	Lummus	Lummus
		Offsite Facilities	.....	$10,000,000	Engineering	Mid 1960	.....	Parsons	Parsons
	S. Roxana, Ill.	*Hydrotreater	25,000 bbls	.....	Under Constr	1959	.....	.....	Procon
	Healdton, Okla.	Exp. Plant	.....	$315,000	Under Constr	.....	.....	Staff	Hudson
Sinclair Refining	East Chicago	Alkylation/LPG	5,000 bbls	.....	Under Constr	Late 1959	.....	Braun	Braun
		*Asphalt Blending	.....	.....	Complete	.....	.....	Sinclair	Catalytic
Skelly Oil	El Dorado, Kan.	HF Alkylation	3,000 to 4,000 bbls	.....	Complete	.....	Phillips	Staff	Staff
		*Gasoline Treater	7,000 bbls	.....	Under Constr	Late 1959	.....	Litwin	Staff
		*Vacuum Distl.	12,000 bbls	.....	Complete	.....	.....	Litwin	Staff
Standard-Indiana	Whiting, Ind.	Crude Distl.	140,000 bbls	.....	Complete	.....	.....	McKee	McKee
		*Vapor Recovery	.....	.....	Under Constr	1959	.....	McKee	McKee
		Vacuum Distl. Tower	36,000 bbls	.....	Under Constr	3rd Qtr. 1959	.....	Braun	.....
		Exp. Cat Cracker	10,000 bbls	.....	Engineering	1960	.....	Kellogg	.....
	Wood River, Ill.	Crude Unit	67,500 bbls	.....	Complete	.....	.....	McKee	McKee
		Cat Cracker	30,000 bbls	.....	Under Constr	1959	.....	McKee	McKee
		Vacuum Distl. Tower	36,000 bbls	.....	Engineering	1959	.....	.....	.....
Standard-Ohio	Lima, Ohio	*Exp. Lube Wax Facilities	.....	$650,000	Under Constr	.....	.....	.....	.....
		*Acrylonitrile	.....	.....	Under Constr	1960	.....	Badger Mfg	Badger Mfg

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 223

With a

PACE *Computer you can*

TORTURE A CAT CRACKER . . .

simulate

any dynamic problem!

These men are simulating the performance of a catalytic cracking tower on a PACE Electronic Analog Computer. They are developing the ideal combination of pressure, temperature and flow for better process control and improved refinery efficiency.

This ability to study dynamic characteristics on electronic analog computers and to test equipment to destruction before it is built—is aiding a variety of industries in upgrading processes and developing new designs. Analog computers simulate machine or process performance and chart accurate graphic pictures of what happens under extremes of speed, pressure, temperature, etc. When destruction or breakdown occurs, the reason is clearly indicated. This helps engineers to "design-out" problems before pilots or prototypes are built. It means new and safer methods of operation can be found—with less engineering time and expense.

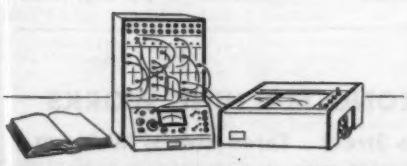
Electronic Associates, the world's largest manufacturer of general purpose electronic analog computers, offers a complete line of analog computing equipment and accessories. And you'll be surprised to learn how easy this equipment is to operate.

To help you solve specific problems and gain first-hand knowledge of the benefits of analog simulation, EAI operates three Computation Centers.

Here, experienced analog specialists and the most advanced equipment combine to provide fast, practical solutions to your most complex problems. For additional information, write for Bulletin CC-821C.

If you would like information on how actual problems were solved with PACE Analog Computers, mention your field of interest and we'll send appropriate literature.

Outstanding career opportunities for engineers with proven ability—résumés invited.



New solid-state computer and desktop X-Y plotter.

EAI ELECTRONIC ASSOCIATES, INCORPORATED

Long Branch, New Jersey

Steam trap dependability is a matter of what the manufacturer puts into the trap

ARMSTRONG TRAPS ARE DESIGNED AND MADE TO GIVE YOU DEPENDABILITY

1. Efficient, proved operating principle

Armstrong Traps provide the most advanced development of the time-proven inverted bucket principle. Simple, but effective, there isn't much that can go wrong.

2. Good design

Armstrong Trap design gives big capacity in a small package. The mechanism is virtually fool-proof. All body styles are easy to inspect and maintain without removal from the line.

3. Highest quality materials of construction

Only the best goes into Armstrong Traps. Bodies are close grained 30,000 tensile iron castings or high quality forgings. Working parts are all tough, corrosion resistant stainless steel.

4. Good workmanship

Armstrong Traps are made by craftsmen who take pride in their work. Careful inspection and frequent checking insure the quality of the trap.

5. Application know-how

Your problem has probably been solved already in the extensive experience of the Armstrong engineering and sales organization. You can be sure of sound, dependable recommendations.

Your local Armstrong Representative can show you what Armstrong dependability can do for you. Call him today or write direct.

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

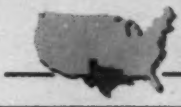
The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS

8524 Maple Street Three Rivers, Michigan

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Sun Oil	Laverne, Okla.	Gas Products Recovery	100 MMcf	$4,000,000	Under Constr	1959	.....	Pritchard	Pritchard
	Toledo	*Tank Gauging System	.....	$230,000	Under Constr	Spring 1960	.....	Staff	Staff
Sunray Mid-Continent	McClain County, Okla.	*Natural Gasoline	5 Mmcf	$1,000,000	Under Constr	1959	.....	Pona	Pona
Texaco	Lawrenceville, Ill.	Cat Reformer	12,000 bbls	.....	Under Constr	4th Qtr. 1959	.....	Bechtel	Betchel
		Hydrotreater	12,000 bbls	.....	Under Constr	4th Qtr. 1959	.....	Bechtel	Bechtel
	Tulsa, Okla.	Alkylation	2,050 bbls	.....	Under Constr	4th Qtr. 1959	.....	Staff	Kaighin & Hughes
Union Carbide	Marietta, Ohio	Liquid epoxy resin	15,000,000 lbs/yr	.....	Under Constr	1959	.....	.....	.....
	Whiting, Ind.	Low-density Polyethylene	72,000,000 lbs/yr	.....	Under Constr	Mid 1959	.....	.....	.....
Vickers	Potwin, Kan.	*Water Disposal	.....	.....	Engineering	Nov 1959	.....	Wilson	Sherwood/ Litwin
Warren Petroleum & Sunray	Forgan, Okla.	Gasoline	100 Mmscf	$3,000,000	Under Constr	Fall 1959	.....	.....	Dresser
Warwick Wax	Chanute, Kan	*Waste Disposal	.....	.....	Engineering	Dec 1959	.....	Litwin	Litwin
		*Vacuum Distl.	500 bbls	.....	Engineering	Dec 1959	.....	Litwin	Litwin
		*Propane Deasphalting	350 bbls	.....	Engineering	Dec 1959	.....	Litwin	Litwin
Witco Chemical	Chicago	Phthalic Anhydride	20,000,000 lbs/yr	.....	Under Constr	1959	S D	S D	S D



Southwest

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
American Cyanamid	Bridgerville, Pa.	*Maleic Anhydride	14,000,000 lbs/yr	.....	Under Constr	Late 1959	SD	SD	SD
American Oil	Texas City	*Relocated Delayed Coker	430 tons	.....	Planning	1959	.....	Tellepsen	Tellepsen
American Petrofina of Texas	Mt. Pleasant, Texas	Platformer	3,000 bbls	$800,000	Complete	.....	UOP	Pritchard	Pritchard
		Alkylation	1,400 bbls	$1,000,000	Complete	.....	UOP	Pritchard	Pritchard
Atlas Processing	Shreveport, La.	Deisopentanizer	4,700 bbls	$3,000,100	Complete	.....	.....	.....	.....
		*Isomerization	3,800 bbls	$3,100,000	Complete	.....	UOP	UOP	Hudson
Bay Petroleum	New Orleans	*Alkylation	2,700 bbls	.....	Under Constr	Early 1960	UOP	Bechtel	Bechtel
		*Exp Cat Cracker	15,000 bbls	.....	Engineering	Early 1960	UOP	UOP	.....
		*Crude	35,000 bbls	.....	Under Constr	Early 1960	.....	Bechtel	Bechtel
Carbide & Carbon	Seadrift, Texas	Exp. Ethylene Oxide	To 200,000,000 lbs/yr	.....	Planning	.....	.....	.....	.....
		Exp. Ethylene Glycol	To 65,000,000 lbs/yr	.....	Planning	.....	.....	.....	.....
Champlin O & R	Bishop, Texas	*Gas Processing Exp.	.....	$3,000,000	Under Constr	1959	.....	Fluor/Staff	Fluor/Staff
Continental Carbon	Ponca City, Okla.	Exp. Carbon Black	75,000,000 lbs/yr	.....	Complete	.....	.....	.....	.....
Copolymer Rubber & Chemical	Baton Rouge	Exp. Butadiene	35,000 short tons yr	.....	Under Constr	.....	.....	.....	.....
Dow Chemical	Freeport, Texas	Acrylonitrile	.....	.....	Under Constr	.....	.....	.....	.....
		Polyethylene	.....	.....	Under Constr	.....	.....	.....	.....
Du Pont	Orange	Polyethylene	.....	.....	Under Constr	.....	.....	.....	.....
	Beaumont	Caprolactam	50,000,000 lbs/yr	.....	Planning	Late 1960	.....	Staff	Staff
	Near New Orleans	Petrochemical	.....	.....	Considering	.....	.....	.....	.....
El Paso Natural Gas	Crane, Texas	Exp. Compression and Treating	.....	$2,000,000	Under Constr	.....	.....	Olsen	Olsen
Firestone	Orange, Texas	*Polyisoprene Polybutadiene	30,000 tons/yr	.....	Engineering	.....	.....	.....	.....
Goodrich-Gulf Chemicals	Port Neches, Texas	Exp. Synthetic Rubber	.....	$1,250,000	Complete	.....	.....	Catalytic	Catalytic
Gulf Oil	Port Arthur	Greasemaking; Packaging	.....	.....	Complete	.....	.....	Sumner Sollitt	Sumner Sollitt
		Gasoline Processing	10,000 bbls	$4,000,000	Complete	.....	UOP	Procon	Procon
		Benzene	32,000 gals	$6,800,000	Complete	.....	UOP	Procon	Procon
Humble	Baytown, Texas	*Phenol Extraction for Cat Cracking feed	31,500 bbls	.....	Under Constr	Aug. 1959	.....	Kellogg/B & R	Staff
		*Polyolefin	40,000 lbs/yr	.....	Under Constr	Jan. 1960	.....	Esso	Staff
	Rusk County, Texas	Remote Absorber	80 Mmcf	.....	Engineering	.....	.....	Staff	.....
	Kleberg County, Texas	Gas Process & Cycling	800 Mmcf	.....	Planning	1960	.....	Staff	.....
Jefferson Chemical	Port Neches, Texas	*Ethanolamines Revamp	.....	.....	Complete	.....	.....	Braun	Braun
		Ethanolamines	.....	.....	Complete	.....	.....	Braun	Braun
Koppers	Port Arthur	Exp. Polyethylene	.....	.....	Planned	.....	Staff	Staff	Staff
La Gloria Oil & Gas	Tyler, Texas	Gas Concentration; Revamp Cat Cracker	.....	.....	Under Constr	.....	UOP	UOP	B & R
Magnolia	Beaumont, Texas	Cat Desulfurization	30,000 bbls	.....	Complete	.....	Socony Mobil	Staff, Foster Wheeler	Foster Wheeler
		Cat Reforming	20,000 bbls	.....	Under Constr	1960	.....	Fluor	Fluor
		*Ethylene	380,000,000 lbs/yr	.....	Under Constr	1961	.....	Kellogg	Kellogg
	Cameron, La.	Gas Processing	120 Mmcf	.....	Complete	.....	.....	Dresser	Dresser
McBride Refining	Port Brownsville, Texas	Refinery Exp.	12,500 bbls	$2,500,000	Planned	.....	.....	.....	.....
Monsanto	Texas City	Exp. Acrylonitrile	100,000,000 lbs/yr	.....	Complete	.....	.....	.....	.....
		Exp. Styrene Monomer	40,000,000 lbs/yr	.....	Complete	.....	.....	.....	.....
		*Exp Polyethylene	100,000,000 lbs/yr	.....	.....	Fall 1959	.....	.....	.....
Petro-Tex	Houston	Isobutylene	2,000,000 gal/yr	$250,000	Complete	.....	.....	.....	.....
Phillips Chemical	Sweeney, Texas	Ethelyene	.....	.....	Under Constr	1959	.....	Staff	Staff
	Pasadena, Texas	Exp Methylvinylpyridine	.....	.....	Under Constr	1959	.....	Phillips	Phillips
	Borger, Texas	*Multi Purpose Chemicals	.....	.....	Engineering	1959	.....	Phillips	Phillips
Phillips Petroleum	Sweeny, Texas	Hexane Isomerization	1,000 bbls	.....	Under Constr	1959	.....	Staff	Staff
	Kansas City	*H.F. Alkylation	6,600 lbs	.....	Under Constr	1960	Phillips	Staff	Staff
Runnels Gas Products & Texas Gas Expl.	Eunice, La.	Gasoline Exp.	100 Mmcf	$500,000	Under Constr	1959	.....	Fluor	Staff
Shell Oil	Norco, La.	Cat Gasoline Fractionator	.....	.....	.....	.....	Monsanto	Leonard	Leonard
		Platformer	16,000 bbls	.....	Under Constr	.....	.....	Procon	Procon
	Weeks Island, La.	Nat. Gas Processing	120 Mmcf	.....	Planning	.....	.....	.....	.....
Shell Chemical	Norco, La.	Acrolein	.....	.....	Under Constr	.....	.....	.....	.....
		Glycerine	.....	$4,500,000	Under Constr	Late 1959	.....	Staff	Parsons/Fluor
	Houston	Phenol	.....	.....	Under Constr	Late 1959	.....	.....	Kellogg
Sinclair Refining	Hulldale Field, Texas	Desulfuriser	.....	.....	Under Constr	.....	.....	.....	.....
Spencer Chemical	Orange, Texas	Polyethylene Exp.	90,000,000 lbs/yr	.....	Under Constr	.....	.....	Staff	Quaker
Sunray Mid-Continent	Jackson County, Texas	*Gas Recovery	30 Mmcf	$800,000	Under Constr	.....	.....	.....	.....
		*Propane *Isobutane *Butane *Natural Gasoline	27,000 gals	.....	Under Constr	.....	.....	.....	.....
	Bossier Parrish, La.	*Exp Recovery Facilities	500 MMcf	$500,000	Planning	.....	.....	.....	.....

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 224

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Sunray Oil	Tulsa	*MEK, Solvent Dewaxing and Wax Deoiling	5,835 bbls	.....	Engineering	.....	.....	Foster Wheeler	Foster Wheeler
Texas Eastman	Longview, Texas	*Exp. Oxo, Normal Butyraldehyde, Iso-butyraldehyde	15,000,000 lbs/yr	.....	.....	.....	.....	Staff	Hudson
		*Exp. Polyethylene	100,000,000 lbs/yr	.....	Complete	.....	.....	Girdler	Hudson
Texaco	Port Arthur	Cat Cracker	60,000 bbls	.....	Complete	.....	.....	Kellogg	Kellogg
		Exp. Alkylation	2,000 bbls	.....	Complete	.....	.....	Staff	Staff & Others
		Cat Reformer	20,000 bbls	.....	Under Constr	2nd Qtr. 1959	.....	UOP	Staff & Fluor
		Udex	28,000 bbls	.....	Under Constr	2nd Qtr. 1959	.....	UOP	Staff & Fluor
	El Paso	Alkylation	1,600 bbls	$250,000	Under Constr	4th Qtr. 1959	.....	Texaco	Sweco
Union Carbide	Seadrift, Texas	Ester & Alcohol	100,000,000 lbs/yr	.....	Design	1960	.....	.....	.....
United Rubber & Chemical	Baytown, Texas	Synthetic Rubber	.....	.....	Under Constr	.....	.....	Day & Zimmerman	Tellepsen
U. S. I. Chem.	Houston	Polyethylene	75,000,000 lbs/yr	$20,000,000	Under Constr	1959	I.C.I.	Kellogg	Kellogg; Tellepsen
Western Nat. Gas	Brownsville, Texas	*Refinery Revamp							
	Hidalgo County, Texas	*Gasoline Extraction							
	Victoria County, Texas	*Gasoline Extraction	3,500 bbls	.....	Under Constr	.....	.....	.....	.....
	Aransas County, Texas	*Gasoline Extraction							

Rocky Mountain

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
American Gilsonite	Grand Junction, Colo.	*Coking Exp	1,100 tons	.....	Engineering	.....	.....	Foster Wheeler	.....
Cartar Oil	Billings, Mont.	Exp. Crude Cap.	34,500 bbls	.....	Complete	.....	.....	Esso	Staff
		*Heavy Cat Naphtha Treater	2,000 bbls	.....	Complete	.....	Howe-Baker	Staff	Staff
		*Light Cat Naphtha Treater	8,000 bbls	.....	Complete	.....			
		Alkylation	2,300 bbls	.....	Complete	.....	UOP	Treco	Treco
		Covert Bauxide Desulfuriser to Hydrofiner	11,000 bbls	.....	Complete	.....	Esso	Treco	Treco
El Paso Natural Gas Products	Jal, N. M.	*Exp. Gasoline Fractionation	1,000 Mmcf	$2,471,000	Engineering	1959	.....	Delta	Delta
		Fractionation	452,000 gals	$730,000	Under Constr	Sept 1959	.....	Stearns-Roger	Bowden
		*Natural Gasoline Absorption	.....	$2,500,000	Under Constr	Aug 1959	.....	Delta	Delta
	San Juan, Utah	*Gasoline	1,500 Mmcf	$5,378,000	Planning	.....	.....	Fish	Fish
Empire Pet.	Denver	*Vacuum Rerun	1,150 bbls	$50,000	Complete	.....	.....	Staff/Litwin	Staff
Pan American	Riverton, Wyo.	Gasoline	.....	$1,000,000	Under Constr	1959	.....	Olsen	Olsen
Southwestern Agro-chemical	Chandler, Ariz.	Ammonia Synthesis	60 tons	$5,000,000	Engineering	Jan. 1960	.....	.....	.....
Texaco	San Juan County, Utah	Gasoline	.....	.....	.....	.....	.....	.....	.....

West Coast

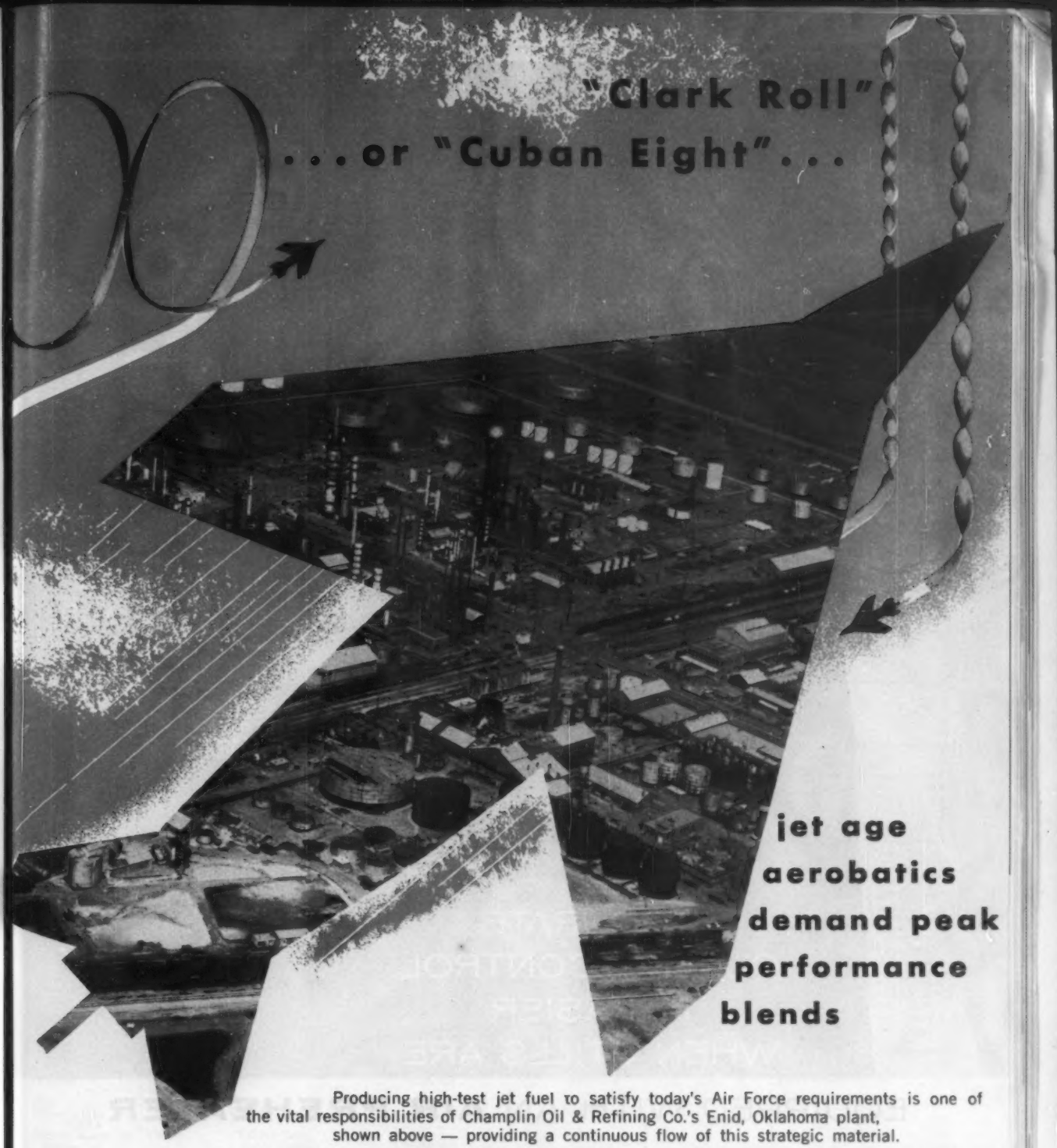
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
American Chem.	Watson, Cal.	*Chemical	.....	.....	Under Constr	Late 1959	.....	Braun	Braun
California Ammonia	Lathrop, Cal.	Ammonia Synthesis	100 tons	$5,000,000	Engineering	1959	.....	Macco	Macco
Collier Carbon & Chemical	Brea, Cal.	*Exp. Refinery	.....	.....	Under Constr	.....	.....	Braun	Ehrhart
		*Ammonia Exp.	.....	.....	Under Constr	Mid 1959	.....	Braun	Ehrhart
du Pont	Antioch, Cal.	Fluorinated Hydrocarbons, Tetraethyl Lead	.....	.....	Under Constr	.....	.....	.....	.....
Fletcher Oil	Wilmington, Cal.	Unifiner Platformer	.....	.....	Complete	.....	UOP	Parsons	Parsons
General Petroleum	Torrance, Cal.	*Exp Delayed Coker	9,300 bbls	.....	Under Constr	Feb 1960	.....	Bechtel/Staff	Bechtel
		*Exp. Platinum Cat Cracker	8,000 bbls	.....	Under Constr	Mid 1959	.....	Braun/Staff	Braun
Vally Nitrogen	Cal.	Ammonia	150 tons	.....	Engineering	1959	Chemico	Chemico	Chemico
Richfield Oil	Watson, Cal.	*Gas & Cat Cracker Revamp	.....	.....	Complete	.....	.....	Braun	Braun
Shell Development	Emeryville, Cal.	Research Lab.	.....	$500,000	Under Constr	.....	.....	.....	.....
Shell Oil	Wilmington	Boiler for Cat Cracker	200,000 lbs	$1,000,000	Under Constr	.....	.....	.....	.....
Signal	Long Beach, Cal.	Rebuild Refinery	.....	.....	Planning	1960	.....	Nofsinger	.....
Standard Oil (Calif.)	El Segundo	Steam Generating	275,000 lbs/hr	$2,000,000	Under Constr	.....	.....	Fluor	Fluor
	Richmond, Cal.	*FCC	40,000 bbls	.....	Under Constr	1959	.....	Fluor	Fluor
		*Butamer	2,000 bbls	.....	Complete	.....	.....	UOP	UOP
	Honolulu	Refinery	35,000 bbls	$40,000,000	Under Constr	1961	.....	Staff/Bechtel	Bechtel/Hawaiian Dredging
Union Oil	Wilmington, Cal.	*Unifiner Reformer	.....	.....	Engineering	Fall 1960	Sinclair/Baker	Braun	Braun
Wilshire	Norwalk, Cal.	*Crude Distillation Revamp	.....	.....	Engineering	.....	.....	Braun/UOP	.....

Canada

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
British American Oil	Clarkson, Ont.	Desulfuriser	8,000 bbls	$2,200,000	Complete	.....	Kellogg	Kellogg	Kellogg
		Compounding, Blending & Grease	.....	$2,900,000	Engineering	.....	.....	Nofsinger	Foster Wheeler
		*Cat Cracker Exp.	6,000 bbls	$1,500,000	Complete	.....	.....	Kellogg	Kellogg
		*Alkylation	2,500 bbls	.....	Complete	.....	UOP	UOP	.....
		*Steam Generating Unit Dist.	.....	$600,000	Complete	.....	.....	Staff	Staff
	Moose Jaw, Sask.	Cat Reformer & HDS	5,400 bbls	$3,900,000	Complete	.....	Atlantic	Lummus/Procon	Lummus/Procon
		Gas Splitter	7,000 bbls		Complete	.....	UOP	Lummus/Procon	Lummus/Procon
	Calgary		7,000 bbls	$4,000,000	Under Constr	.....	.....	Procon	Procon

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 227



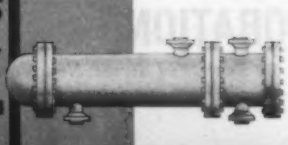
jet age aerobatics demand peak performance blends

Producing high-test jet fuel to satisfy today's Air Force requirements is one of the vital responsibilities of Champlin Oil & Refining Co.'s Enid, Oklahoma plant, shown above — providing a continuous flow of this strategic material.

Another important function of the Enid plant is the production of high octane motor fuel, processed to the needs of modern high-compression engines for dependable "over-the-ground" power.

High-octane production at its Enid plant is centered in Champlin's HF alkylation unit, wherein Western Heat Exchangers are a major factor in the production of the alkylate blending component used in the manufacture of this dependable fuel. The HF alkylation unit was designed and built by Badger Manufacturing Company.

WESTERN
HEAT EXCHANGERS
STERN SUPPLY COMPANY
P.O. Box 1888 – Tulsa, Oklahoma



Western Heat Exchangers have become a significant factor in all phases of the process industry. A Western representative is waiting to show you why.

OCTANE RATING IS DETERMINED by running fuel samples in a single-cylinder test engine, like the one that's shown in operation.

EQUIPPED WITH AN **AIR PREHEATER**

Average product ratings are up as much as two octane numbers at one East Coast refinery, because their Air Preheater permits maximum utility and completely accurate control of advance design units. At this refinery, the ability to control product quality accurately resulted in an extra annual income of $58,000.

You can get continuous peak performance from the most modern heat transfer system with a Ljungstrom® gas-to-gas regenerator. A Ljungstrom can recover as much as 1000° F heat from the exhaust of stills or boilers. Instead of letting this heat escape up the stack, the Ljungstrom returns it to the furnace combustion air.

Hotter combustion air can boost the output of a pipe still, too — by as much as 25%. Or, it can cut your fuel bill by an equal amount. Some plants have "written off" the cost of their Ljungstrom in 9 months.

Here's documented evidence. One company's fuel savings with a Ljungstrom Air Preheater are factually described in a published magazine article by O. F. Campbell. A reprint of this case history is yours free. Simply write to Air Preheater Corp.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

25¢ per barrel of crude

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
British Petroleum	Ville D'Anson	*Crude Distl	25,000 bbls	.....	Under Constr	Spring 1960	.....	Lummus	Lummus
		*Cat Cracker	9,000 bbls	.....	Under Constr	Spring 1960	UOP	Lummus	Lummus
		*Platformer	6,000 bbls	.....	Under Constr	Spring 1960	UOP	Lummus	Lummus
		*Cat Desulfuriser	12,000 bbls	.....	Under Constr	Spring 1960	.....	Lummus	Lummus
		*Cat Polymerisation	700 bbls	.....	Under Constr	.....	UOP	Lummus	Lummus
Canadian Industries,	Edmonton, Alb.	Exp. Polythene	40,000,000 lbs/yr		Under Constr	1959	.....	.....	Poole Constr
Canadian Oil	Corunna, Ont	Crude Distl.	20,000 bbls	$3,000,000	Engineering	1959	.....	Kellogg	Kellogg
		*Steam Boiler	150,000 lbs/yr	.....	Under Constr	Aug 1959	.....	John Thompson/ Leonard	John Thompson/ Leonard
		*Unifiner	5,000 bbls	.....	Under Constr	Oct 1959	.....	UOP	Procon
Canadian Petrofina	Montreal	Exp. Capacity	30,000 bbls	$5,000,000	Under Constr	.....	.....	Staff	Procon (Canada)
Cyanamid of Canada	Hamilton, Ont.	Urea; Ammonia	.....	.....	Complete	1959	.....	Chemico	Chemico
	Welland, Ont.	*Nitric Acid	190 tons	.....	Engineering	1960	Uhde	McKee	McKee
Devon-Palmer & Texas Gulf Sulfur	Calgary, Alb.	Sulfur Extraction	400 tons	$8,000,000	Planning	Mid 1959	.....	.....	.....
Dow Chemical (Canada)	Sarnia, Ont.	*Polyethylene	.....	.....	Complete	.....	.....	Catalytic	Catalytic
Imperial Oil	Sarnia	Refinery Exp.	94,000 bbls	$5,360,000	Under Constr	Summer 1959	.....	Staff	Staff
	Edmonton, Alb.	*Alkylation	1,500 bbls.	$2,175,000	Engineering	Feb 1960	.....	.....	.....
	Calgary	Crude Cap.	14,700 bbls						
		Cat Cracker	7,000 bbls	$16,400,000	Complete	.....	.....	Canadian Bechtel/Staff	Canadian Bechtel
		Powerformer	3,000 bbls						
		Offsite Facilities							
	Regina	Powerformer	2,500 bbls	$2,550,000	Under Constr	Fall 1959	.....	Canadian Kellogg	Canadian Kellogg
	Winnipeg	Alkylation	740 bbls	$2,600,000	Under Constr	Sept. 1959	.....	Canadian Bechtel	Canadian Bechtel
Irving Refining	St. John, New Brunswick	Hydrogen	.....	.....	Engineering	1960	.....	Girdler Bechtel	Canadian Bechtel
		*Crude Desalter	38,500 bbls	.....	Under Constr	Dec. 1959	Howe-Baker	Bechtel	Bechtel
		*Gas Treating-Sulfur Recovery	.....	.....	Engineering	Mid 1959	.....	Parsons	.....
Nevis Operators Committee	Nevis, Alb.	*Gas Processing	43 Mmcf	$3,000,000	Engineering	.....	.....	Fluor	Fluor
		*Sulfur Recovery	125 tons						
Nottingham Gas Carnduff Gas	Saskatchewan	*Gas Processing Treating, Gathering	8.5 Mmcf	.....	Engineering	1959	.....	Tellepsen	Tellepsen
Shell Oil (Canada)	Bronte, Ont.	Refinery	.....	.....	Planning	.....	.....	Treco/Staff	.....
Steelman Gas	Southeast Saskatchewan	Natural Gas	25 Mmcf	$6,500,000	Under Constr	.....	.....	Stearns-Roger	Treco
Texaco, Canada	Montreal	*Sulfuric Acid Alkylation Feed Preparation and Treating	2,200 bbls	.....	Engineering	.....	.....	Foster Wheeler	Foster Wheeler
Texas Gulf	Calgary, Alb.	*Sour Gas Recovery	100,000 tons/yr	.....	Under Constr	Mid 1959	.....	Shell/Devon Palmer	Shell/Devon Palmer
Westcoast Transmission	Coleman, Alb.	Gas Processing	.....	$15,000,000	Planning	.....	.....	.....	.....

Latin America

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
ARGENTINA									
Argentine Government	Santa Fe Province	Naphtha Reforming	.....	.....	Planning	.....	.....	.....	.....
Carbometal	Mendoza	Polyvinyl Choride	4,500 tons/yr	.....	.....	.....	.....	.....	.....
		Acetylene	200 tons/yr	.....	.....	.....	.....	.....	.....
		Plastics	7,500 tons/yr	.....	Planning	.....	Monsanto	Monsanto	Monsanto
Monsanto	Buenos Aires	*Phthalic Anhydride	.....	.....	Under Constr	.....	.....	Foster Wheeler	.....
BRAZIL									
Alba (Borden)	Cubatao	Methanol, Formaldehyde, Synthetic Resins	30 tons	$4,600,000	Complete	.....	Vulcan Texaco Fisher	Vulcan/Girdler	Staff/Girdler/ Austin: Montreal, SA
Empresa Colombiana de Petroleos	El Centro	Nat. Gasoline	51.4 Mmcf	$2,700,000	Under Constr	October 1959	.....	Parsons	Parsons
North American Solvay	Sao Paulo	Ethylene Purification	20 tons	.....	Under Constr	Mid 1959	.....	Hydrocarbon	Hydrocarbon/ SETAL
Petroleo Brasileiro	Mataripe	Atmospheric & Vacuum Distl. Cat Cracker Gas Recovery, Wax Treating, Lube	.....	.....	Under Constr	1960	Kellogg	Kellogg	Kellogg/Brasileira/Montreal, S A
	Rio de Janeiro	Refinery	90,000 bbls	$60,000,000	Under Constr	1961	.....	Foster Wheeler	.....
	South Brazil	Refinery	70,000 bbls	.....	Planning	.....	.....	.....	.....
	Cubatao-Sao Paulo	*Exp. Refinery	90,000 bbls						
		Cat Reformer	12,000 bbls	$10,000,000	Planning	Mid 1962	.....	.....	.....
		Aromatics Extr.	3,000 bbls						
		Ethane Cracking	3.77 MMcf						
Petrobras	Duque de Caxias Rio de Janeiro	*Refinery	90,000 bbls	.....	Engineering	.....	.....	Foster Wheeler	.....
Uhde	Cubatao	Urea	.....	.....	.....	.....	.....	Uhde	Uhde
Union Carbide	Cubatao	Polyethylene	.....	.....	Under Constr	.....	.....	B & R	B & R
CHILE									
Empresa Nacional del Petroleo	Concon	Refinery Exp:							
		Crude Topping	24,000 bbls						
		Vacuum	10,080 bbls						
		Orthoflow FCC	12,000 bbls	$15,000,000	Under Constr	Early 1960	Kellogg	Kellogg	Staff & Kellogg
		SBK Cat Reforming and Desulfurization	6,000 bbls						
		Alkylation	1,100 bbls						
COLOMBIA									
Empresa Colombiana de Petroleos	Barranca-Bermeja	Exp. Propane Recovery	1,000 bbls	$1,000,000	Planning	.....	.....	.....	.....
ECUADOR									
Anglo-Ecuadorian Oilfields	Santa Elena Ancon	Atomspheric Distl.	7,700 bbls	$4,500,000	Under Constr	.....	UOP	Procon	Procon
		Thermal Cracking	6,000 bbls	.....	Under Constr	.....	UOP	Procon	Procon
GUATAMALA									
Breaux Oil Refg	Bridge Puerto Barrios	*Refinery	4,000 bbls	.....	Planning	.....	.....	Lummus	Lummus

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 228

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
MEXICO									
Pemex	Atzcapotsalco	*Cat Cracking Feed Preparation	25,000 bbls	.....	Under Constr	1959	Esso/ UOP/ Phillips	McKee	McKee
		Polymerization Sulfur							
	Ciudad Madero	Topping	110,000 bbls		Under Constr				
		Cat Cracking	25,000 bbls		Under Constr				
		Gas Concentration; Polymerization; Sulfur	.....	.....	Under Constr Under Constr	Late 1959	Esso/ UOP	McKee	McKee
	Salamanca	Grease	25 tons	$1,700,000	Engineering	.....	.....	McKee	Staff
		Cat Cracker	15,000 bbls	.....	Planning	.....	.....	.....	.....
		*Anhydrous Ammonia Exp Refinery	.....	$21,000,000	Planning	.....	.....	Lummus	Lummus
NETHERLANDS ANTILLES									
Lago Oil & Transport	Aruba, N. A.	Revamp Distl. & Visbreaking	.....	.....	Engineering	Nov. 1959	.....	Kellogg	Kellogg
PANAMA									
Refiner a Petroquimica de Panama	Portobelo	Refinery	55,000 bbls	$40,000,000	Engineering	1961	.....	Foster Wheeler	Foster Wheeler
Refineria Panama, S A	Las Minas Bay Colon	Refinery; Petrochemicals	70,000 bbls	$50,000,000	Under Constr	Late 1960	.....	Kellogg	.....
PARAGUAY									
Compagnie Fives-Lille	Asuncion, Paraguay	Refinery	10,000 bbls	.....	Planning	.....	.....	.....	.....
PUERTO RICO									
Commonwealth Oil Refining	Guayanilla Bay	Unifiner	6,500 bbls	$1,200,000	Under Constr	1959	UOP	Howe-Baker	Procon
		Gasoline	2,000 bbls	.....	Complete	.....	Howe-Baker	Howe-Baker	Procon
		Ref. Modifications	75,000 bbls	$6,300,000	Under Constr	1959	.....	UOP	Procon-Others
	Ponce	*Electrostatic Desulfurization	2,000 bbls	.....	Complete	.....	Howe-Baker	Lacer	Procon
Union Carbide Caribe	Ponce	Ethylene-Glycol	500,000 lbs	$28,500,000	Planning	1959	.....	B & R	B & R
TRINIDAD									
Federation Chemicals,	Point Lisas	Nitrogen	100 tons	$12,000,000	Under Constr	1959	Kellogg	Braun/Kellogg	Braun
		Urea	70 tons	.....	.....	.....	Stami-carbon	Braun	Braun
		Ammonia	100 tons	.....	.....	.....	Kellogg	Kellogg	Braun
		Sulfuric Acid	200 tons	.....	.....	.....	Mon-santo	Leonard	Braun/Kellogg
		Ammonium Sulfate	245 tons	.....	Under Constr	1959	Stami-carbon	Braun/Kellogg	Braun/Kellogg
Texaco Trinidad	Pointe-a-Pierre	Crude Distl.	15,000 bbls	.....	Under Constr	.....	UOP	Procon	Procon
URUGUAY									
Administracion	Montevideo	Crude Desalter	28,000 bbls	$12,000,000	Under Constr	Late 1959	Howe-Baker	Kellogg/Staff	
Nacional de Combustibles Alcohol Y Portland		Vac. Distl.	10,000 bbls	.....	.....	.....	.....		
		Cat Cracker	5,000 bbls	.....	.....	.....	.....		
		Cat Reformer	3,000 bbls	.....	.....	.....	.....		
		Gas Concent. & Bottling	.....	.....	.....	.....	.....	Kellogg-/Staff	Staff
		Gas Sweetening	4,500 bbls	.....	.....	.....	.....		
		Sulfur Recovery	6 tons	.....	.....	.....	.....		
		Power & Offsite Facil.	3,000 KW	.....	.....	.....	.....		
VENEZUELA									
Cia Shell	Cardon	Distl.	80,000 bbls	$20,000,000	Under Constr	.....	.....	.....	.....
		Alkylation	2,800 bbls	.....	Under Constr	.....	.....	.....	.....
	La Paz, Maracaibo	Exp. Compressor	.....	.....	Complete	.....	.....	Lummus	Lummus
Creole Pet.	Amuay Bay	Naphtha Fractionator	45,000 bbls	$3,800,000	Under Constr	Late 1959	.....	Esso	Lummus
Socony Mobil	El Palito	Refinery	50,000 bbls	$28,000,000	Under Constr	Late 1959	.....	Kellogg	Kellogg
Venezuela Gulf Refg.	Puerto la Cruz	Crude Distl.	65,000 bbls	.....	Under Constr	Late 1959	.....	Foster Wheeler	Foster Wheeler

Europe and Africa

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
AUSTRIA									
Austrian Oil Administration	Schwechat near Vienna	Crude Distl. Cat Reformer, Gas Recovery, Chemical	35,000 bbls 7,000 bbls	$22,300,000	Engineering	Late 1959	.....	Lurgi	Lurgi
Danubia Petrochemie A. G.	Schwechat near Vienna	Polypropylene	11,000,000 lbs/yr	.....	.....	.....	.....	.....	.....
BELGIUM									
Cobenam, S.A.	Antwerp	*Polyethylene	15,000 tons/yr	.....	Planning	Mid 1960	.....	Union Carbide	Union Carbide
CANARY ISLANDS									
Cepsa	Las Palmas	Ammonia	90 tons	.....	Engineering	.....	Hoechst	Uhde	Uhde
		*Ammonium Sulfate	365 tons	.....	Engineering	Mid 1960	Uhde-Texaco	Uhde	Uhde
ENGLAND									
British Petroleum	Kent	Hydrofiner II	10,000 bbls	.....	Complete	.....	.....	Kellogg	McAlpine, Wimpey
		Udex	500 bbls	.....	Complete	.....	.....	UOP/Badger Mfg	McAlpine, Wimpey
Courtlands	Spondon	*Exp. Refinery	.....	.....	Complete	.....	.....	.....	.....
Esso Petroleum	Fawley	Steam Cracker			Complete				
		Butene Dehydrogenation			Complete				
		Ethylene Recovery	40,000 lt tons/yr	$27,000,000	Complete	.....	.....	Foster Wheeler	Foster Wheeler
		Butadiene Extraction			Complete				
		Powerformer	21,000 bbls	$12,000,000	Complete	.....	.....	Lummus	Lummus
		Sulfur	60 tons	$700,000	Complete	.....	.....	Foster Wheeler	Foster Wheeler
	Milford Haven	*Atmospheric Distl	100,000 bbls						
		Powerformer	16,500 bbls						
		Hydrofiner	16,500 bbls	.....	Under Constr	Late 1960	.....	Foster Wheeler	Foster Wheeler
		Electric Coalescer	31,500 bbls						
		Other Auxiliaries	.....						
Imperial Chemical Industries	Billingham	*Electrostatic Desulfurization	1,150 bbls	.....	Under Constr	1959	Howe-Baker	Kellogg	Kellogg
Malta Gas Board	Valetta	Catalytic Oil Gasification	1 Mmcf	.....	Under Constr	1959	.....	Power Gas	Power Gas
Mobil Oil Co., Ltd.	Coryton	Crude Unit Exp.	5,000 bbls	.....	Under Constr	.....	.....	Staff	Staff
Monsanto	Newport	*Maleic Anhydride	15,000,000 lbs/yr	.....	Under Constr	Late 1960	SD	SD	SD
North Thames Gas Board	Romford	Refinery Tail Gas Reforming	36 Mmcf	.....	Under Constr	.....	.....	H & G	H & G
North Western Gas Board	Manchester Partington	Pressure Oil Gasification	7.5 Mmcf	.....	Engineering	Dec. 1959	Texaco/ others	H & G	H & G
Petrochemicals	Partington, Nr. Manchester	Exp. Ethylene	30,000 tons/yr	.....	Engineering	.....	.....	H W P	H W P
	Partington	Ethylene Oxide	25,000 tons/yr	.....	.....	.....	.....	.....	.....
Shell Refining	Shell Haven	Hydrodesulfurizer & Gerboto Modifications	.....	.....	Under Constr	1959	.....	Lummus	Lummus
		Hydrodesulfurizer	16,000 bbls	.....	Projected	1960	.....	.....	.....
	Stanlow	Udex	.....	.....	.....	.....	UOP	.....	.....

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 231

PARTS/BILLION

detection of gases and vapors in air or process streams

It's feasible now with new ionization instrument from MSA

such acid gases as:
HCl · HF · SO_2 · HCN · N_2O_4
such alkaline gases as:
ammonia · hydrazine · amines
such halogenated chlorinated hydrocarbons as:
carbon tetrachloride · trichloroethylene
ethylene chloride · ethylene bromide
and some insecticides
and in addition:
nickel carbonyl · tetra-ethyl lead
and even oxygen in non-electro-negative gases

... the M-S-A® BILLION-AIRE* ANALYZER continuously indicates and records contaminants listed above in the range of parts per billion to parts per million

PRINCIPLE OF OPERATION

For all of the above listed applications except oxygen measurement, the gas of interest is converted to an aerosol before introduction into the measuring system.

The M-S-A Billion-Aire measures electrically, in a specially designed ionization chamber, any decrease in the conductivity of the treated gas samples caused by removal of ions by the particulate. A radioactive material (of a strength comparable to a luminous watch dial) in the chamber produces continuous ionization.

VERSATILITY

As the name implies, the M-S-A Billion-Aire continuously measures traces of gases and vapors in the parts per *billion* range. We could rattle off a hundred and one uses for this unique ionization detection system if space permitted. Its scope of capabilities is extremely widespread.

SELECTIVITY

Various sensitizing techniques assure a wide range of selectivity. This new instrument already detects a substantial number of gases and vapors. The number increases as more and more new sensitizing techniques are introduced.

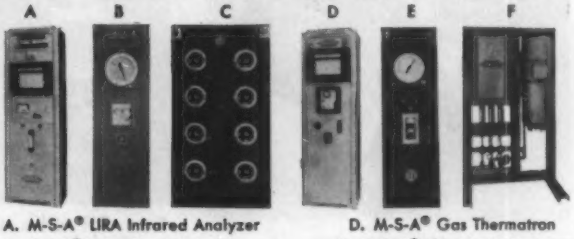
*Trademark

ACCURACY

Sustained accuracy of the M-S-A Billion-Aire is provided by use of a compensated detection system incorporating two similar ion chambers. One is supplied with reagent or converter. The other, with parallel flow of untreated sample gas. The response of the instrument is practically independent of flow rate.

THE MSA INSTRUMENT SPECIALIST

He has the facts. Over thirty years of delving and anticipation in the field of gas analysis have helped our company prepare this man. Ask him for specific information on the M-S-A Billion-Aire. And write us for helpful literature.



A. M-S-A® LIRA Infrared Analyzer
B. M-S-A® Inert Gas Analyzer
C. M-S-A® Combustible Gas Analyzer
D. M-S-A® Gas Thermatron
E. M-S-A® Oxygen Indicator
F. M-S-A® Water Vapor Recorder

INSTRUMENT DIVISION • Mine Safety Appliances Company • Pittsburgh 8, Pennsylvania MSA®

FLUIDICS

. . . is a new PFAUDLER PERMUTIT program providing a modern, imaginative approach—plus the specialized materials and equipment—for handling and processing more profitably the liquids and gases which are the lifeblood of our manufacturing economy

FLUIDICS includes: **corrosioneering • water treatment • waste treatment • reactions • polymerization • ion exchange • fluid analysis, metering and control • agitation • evaporation • distillation • drying • blending • valving • flow rate control • piping • storing • centrifuging • filling • heat transfer, etc.**

Whenever you have a fluid-handling problem, look to this Pfaudler Permutit FLUIDICS program for the best solution.

For copies of bulletins mentioned, write our Pfaudler Division, Dept. PR-79, Rochester 3, N. Y.

During recent months the FLUIDICS program has introduced some startling innovations and improvements in equipment, materials and methods. Here are a few highlights of recent developments from our Pfaudler Division.

30% more thermal shock resistance was the keynote of our announcement of new Glasteel 59. Now you have the protection of a 260° F. temperature differential at a vessel operating temperature of 250° F. Also 20% greater abrasion resistance. Fully corrosion resistant to all acids except hydrofluoric. Alkali resistance twice that of hard glass labware. Now standard on all Pfaudler equipment. Request Bulletin 980.

Glassed ductile iron fittings* with strength comparable to Glasteel's. 60,000 tensile, 45,000 yield, 15% elongation. 2½ to 3 times stronger than conventional gray iron after glassing. Thermal shock resistance comparable to Glasteel's; same is true for corrosion resistance. 45° and 90° elbows, tees, crosses in 1½, 2, 3, 4, and 6-inch sizes. Request Bulletin 977.

*Pat. Pending

Large titanium, tantalum, zirconium equipment now available. New talents and welding methods like those used to make inert gas chamber shown now make it possible to specify large Pfaudler vessels made from the wonder metals. 134 sq. ft. heat exchanger, 23-foot scrubber column, and petroleum burner are among units already in operation offering excellent corrosion resistance and long service life. Specific inquiries welcomed.

New BH drive lasts longer, aligns faster, runs quieter. Wider bearing spread cuts shaft whip and run-out. Pilot fit assures perfect alignment. All anti-friction bearings. No oil leakage. Install either stuffing box or mechanical seal without removing drive from vessel. Request Bulletin 972.

Tantalum bayonet heaters. Offer 100% corrosion resistance for practically *all* chemical processing applications. They give optimum heat transfer, too, because tantalum's high tensile strength permits an extremely thin tantalum envelope over the inner steam ejector tubes. No fouling factor to consider. Standard sizes: 1½" tubes in lengths to 72" in clusters up to 5 units; 2" tubes in lengths up to 84" in clusters up to 4 units. Heat transfer areas to 15 sq. ft. Request Bulletin 978.

Pfaudler has manufacturing plants in Germany (Pfaudler-Werke A.G.), Great Britain (Enamelled Metal Products Corp. Ltd.), Canada (Ideal Welding Co. Ltd.), Mexico (Arteacero-Pfaudler, S. A.) and Japan (Shinko-Pfaudler Co., Ltd.), and four plants in the U.S. Sales Offices and representatives in leading cities throughout the free world.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
South Eastern Gas Board	Isle of Grain	Cat Oil Gasification	15 Mmcf	.....	Complete	.....	.....	Power Gas	Power Gas
		*Hydrogen	18 MMcf	.....	Under Constr	Late 1960	.....	Woodall-Duckham	Woodall-Duckham
Southern Gas Board	Southampton	Refinery Tail Gas Reforming	16 Mmcf	.....	Under Constr	.....	.....	H & G	H & G
	Reading	Catalytic Oil Gasification	7 Mmcf	.....	Under Constr	1959	.....	Power Gas	Power Gas
FRANCE									
Compagnie de Raffinage Shell Berre	Petit Couronne	Distl.	80,000 bbls	.....	Under Constr	.....	.....	.....	.....
		Hydrodesulfuriser	11,000 bbls	.....	Under Constr	4th Qtr. 1959	.....	.....	.....
		Platformer	14,000 bbls	.....	Engineering	1960	.....	Procon	Procon
	Berre l'Etang	*Furfural	3,500 bbls	.....	Under Constr	.....	.....	Foster Wheeler	Foster Wheeler
Comp Francaise de Raffinage	Gonfreville l'Orcher	Ethylene	30,000 tons/yr	.....	Under Constr	1959	.....	KIC	.....
Compagnie Francaise de Petrole; Compagnie Francise de Raffinage; Peshelbronn	Strasbourg	Refinery	70,000 bbls	.....	Planning	.....	.....	.....	.....
Esso Standard	Port Jerome	Powerformer	11,900 bbls	.....	Under Constr	.....	Esso	Foster Wheeler	Foster Wheeler
		Steam Cracker	5,000 bbls	.....	Under Constr	1959	Esso	Foster Wheeler	Foster Wheeler
		Dodecylbenzene	13,500,000 tons/yr	.....	Under Study	.....	Esso	Foster Wheeler	Foster Wheeler
Houilleres du Bassin de Lorraine	Carling	Acetylene	.....	.....	Under Constr	.....	.....	SBA	SBA
		Styrene Monomer	.....	.....	Under Constr	1959	.....	SBA	SBA
Manufacture Normande de Polyethylene	Gonfreville	Polyethylene	.....	.....	Under Constr	.....	Phillips	.....	S T E C
Marles-Kuhlmann	Gonfreville	Ethylene Oxide	.....	.....	Under Constr	.....	S D	Staff	.....
Mobil Oil Francaise	Gravenchon	Lube Exp.	.....	.....	Engineering 2nd phase	.....	.....	.....	.....
					Planning 3rd phase	1959	.....	.....	.....
Naphtachimie	Lavera	Ethylene Oxide Exp.	31,000,000 lbs/yr	.....	Engineering	.....	SD	SFST	SFST
		*Expand Ethylene Oxide	31,000 lbs/yr	.....	Engineering	1960	SD	SFST	SFST
Omnium Francais de Petroles		Refinery	75,000 bbls	.....	Planning	.....	.....	.....	.....
Potasse et Engrais Chimiques	Grand Couronne	Ammonia	.....	.....	.....	.....	.....	Kellogg	Kellogg
Societe des Produits d'Aquitaine	.....	Ammonia	300 tons	$6,000,000	Engineering	1959	.....	Chemico	Chemico
	Lacq	Acetylene from Nat. Gas	75 tons	.....	Under Constr	.....	.....	BASF	.....
Societe du Caoutchouc Butyl	Port Jerome	Butyl Rubber	20,000 tons/yr	.....	Complete	.....	Esso	Braun	Braun
Soc. Francaise des Petroles BP	Dunkirk	Cat Reformer	10,000 bbls	.....	Complete	.....	.....	UOP/Kellogg	.....
Soc. Nationale des Petroles D'Aquitaine	Lavera	*Selective Hydrogenation	3,500 bpsd	.....	Engineering	April 1960	.....	.....	Technip
	Lacq	Desulfurisation	140 Mmcf	.....	Under Constr	.....	.....	Foster Wheeler Soc Chimique/	Foster Wheeler Soc Chimique
		Desulfurisation	175 Mmcf	.....	Engineering	1959	.....	Foster Wheeler Soc Chimique/	Foster Wheeler Soc Chimique
		Distillation Recovery II	112 Mmcf	.....	Under Constr	1959	.....	Hydrocarbon/ Lummus/	Hydrocarbon/ Lummus/
		Sulfur Recovery Phase II	970 tons	.....	Under Constr	.....	Parsons	Parsons/Heurtey	Parsons/Heurtey
		Sulfur Recovery Phase III	780 tons	$22,000,000	Engineering	1959	Parsons	Heurtey Parsons & Heurtey	Heurtey Parsons & Heurtey
		Sulfur Recovery Phase IV	1,000 tons	.....	Engineering	1961	Parsons	Parsons & Heurtey	Parsons & Heurtey
		*Gas Plant Sections 4 & 5	.....	.....	Planning	.....	.....	Lummus	Lummus
		Ethylene	25,000 tons/yr	.....	Engineering	1960	.....	Hydrocarbon	Staff
EAST GERMANY									
Ministry of Coal & Energy	Rostock	Catalytic Oil Gasification	2.4 Mmcf	.....	Under Constr	.....	.....	Power Gas/ Didier	Power Gas/ Didier
WEST GERMANY									
B.P. Benzin und Pet	Dinslaken	Refinery	100,000 bbls	.....	Under Constr	1960	.....	Kellogg	.....
Buna Werke Huels	Marl, Kreis Recklinghausen	Synthetic Rubber	45,000 tons/yr	$37,000,000	Under Constr	.....	Esso; R & E Houdry; Firestone	Staff	Staff
Chemische Fabrik Holten	Ludwigshaven a Rein	Ethylene Oxide	9,000,000 lbs/yr	.....	Under Constr	.....	S D	S D	.....
Chemische Werke Huls	Marl	Polyethylene	6,000 tons/yr	.....	Planning	Summer 1959	Ziegler	Staff	Staff
Durag-Nerag	Misburg, Hannover	*Platformer, Sulfur Recovery	4,500 bbls.	.....	Engineering	July 1960	UOP	Lurgi	.....
		*Delayed Coker	3,000 tons	.....	Engineering	.....	.....	Lummus	Lummus
		Selective Cracker Natural Gasoline	21,000 bbls						
Deutsche Shell	Harburg	Refinery with Crude Distiller Cat Reformer Hydrodesulfurization	40,000 bbls	.....	Under Constr	.....	.....	Lummus	.....
	Godorf	Refinery	30,000 bbls	.....	Under Constr	1960	.....	.....	.....
Erdolchemie	Dormagen	*Ethylene	65,000 tons/yr	.....	Complete	.....	Lurgi/ Duhrgas	Lurgi/Linde	Lurgi/Linde
	(Niederrhein)	Ethylene Oxide	36,000 tons/yr	.....	Complete	.....	SD	SD	Farbenfabriken Bayer
		Ethylene Glycol	.....	.....	Complete	.....	Farbenfabriken Bayer	Farbenfabriken Bayer	Farbenfabriken Bayer
		Propylene Oxide	20,000 tons/yr	.....	Under Constr	Mid 1959	Farbenfabriken Bayer	Farbenfabriken Bayer	Farbenfabriken Bayer
		Ethylene	200,000 tons/yr	.....	Under Constr	End 1959	.....	S & W	S & W
		Ethanol	18,000 tons/yr	.....	Under Constr	End 1959	Shell	S & W	S & W
		Butadiene	30,000 tons/yr	.....	Engineering	Late 1960	.....	.....	.....
		Gasoline Selective Hydrogenation	90,000 tons/yr	.....	Under Constr	End 1959	BP	BP/Lurgi	Lurgi
Esso	Cologne	Steam Cracker	5,600 bbls	.....	Complete	.....	.....	Kocks Still	.....
		*Butadiene	.....	.....	Under Constr	Summer 1959	Esso	Braun/Still	Braun/Still
		Ethylene	.....	.....	Under Constr	Summer 1959	Esso	Lurgi/GHH	Lurgi/GHH
		Propylene	.....	.....	Under Constr	Summer 1959	Esso	Kocks	Kocks
	Hamburg	Heating Oil Sweetening	6,300 bbls	.....	Complete	.....	Esso	Lurgi	.....
		Solvents Hydrofiner	3,040 bbls	.....	Complete	.....	Esso	Lurgi	.....
Feldmuhle	Lulsdorf	Ethylene	40,000 tons/yr	.....	Engineering	.....	.....	Hydrocarbon Hydro M	Hydro M

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 232

CONSTRUCTION BOXSCORE—*Continued*

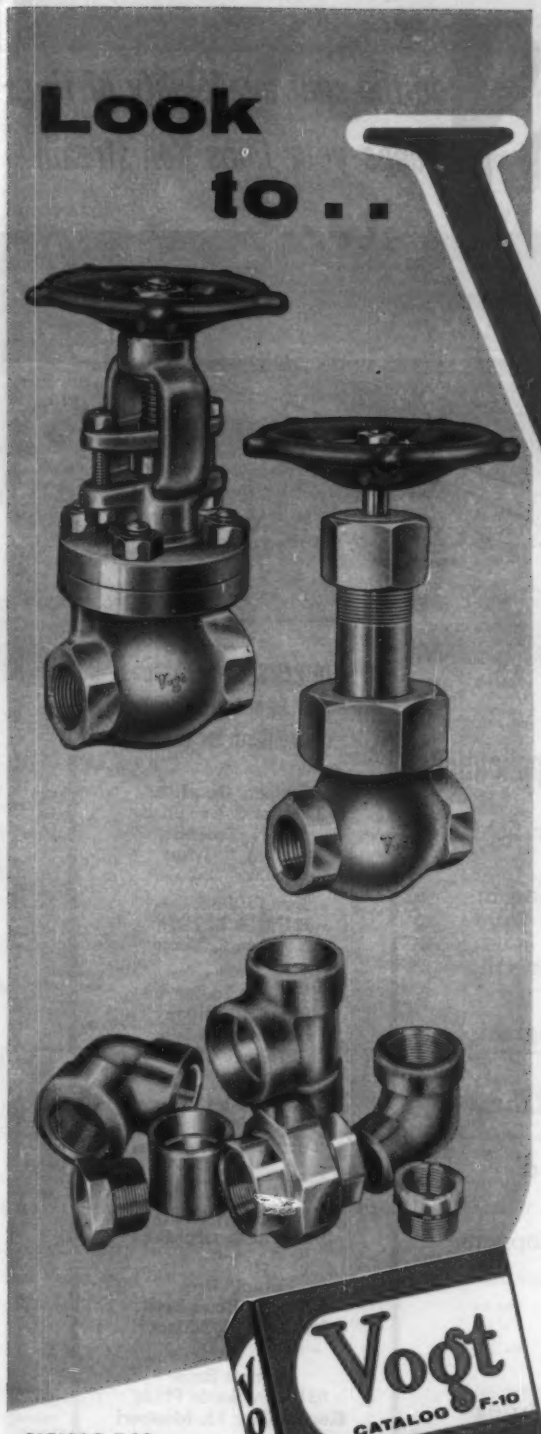
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Gewerkschaft Erdol-raffinerie Emsland	Lingen Holt-hausen	*Crude	32,000 bbls	.....	Under Constr	Early 1960	.....	Lurgi	Lurgi
		Unifiner-Platformer	4,700 bbls	.....	Planning	.....	UOP/ Shell	Lummus	Lummus
		Gas Oil De-Sulfurizer	5,500 bbls	.....	Planning	.....	UOP/ Shell	Lummus	Lummus
		Kerosine Desulfurization	270 tons	.....	Under Constr	Early 1960	.....	Lurgi	Lurgi
		*Gasoline Desulfurization	207 tons	.....	Under Constr	Early 1960	.....	Lurgi	Lurgi
Frisia	Emden	Refinery	30,000 bbls	$17,000,000	Engineering	1959	.....	Parsons	Parsons
Purfina Mineraal-raffinerie	Duisburg	Topping, Platformer Hydro-desulfurizer	20,000 bbls	.....	Under Constr	Late 1959	UOP, Shell	Lummus/Uhde	Lummus/Uhde
Rheinische Olefinwerke	Wesseling Bez. Koln	Polyethylene	.....	.....	Under Constr	Mid 1959	Phillips	Braun/Staff	.....
		Ethylene	.....	.....	Engineering	Jan. 1961	Kellogg	Braun/Lurgi	.....
Ruhrchemie	Oberhausen-Holten	*Platformer	2,000 bbls	.....	Under Constr	Jan. 1960	UOP	Procon	Procon
		*Unifiner	2,900 bbls	.....	Under Constr	Jan. 1960	UOP	Procon	Procon
Scholven Chemie	Gelsenkirchen-Bauer	*Crude Distl Cat Reformer Natural Gasoline	36,000 bbls	.....	Complete	.....	.....	.....	Lummus
Westdeutsch Erdolleitung	Ruhlermoor	*Crude Desalter	5,700 bbls	.....	Engineering	Summer 1959	Howe-Baker	Uhde	Dortmund
GREECE									
Greek Government	Ptolemaeus, Greece	*Ammonia	300 tons	.....	Engineering	Mid 1962	Uhde, Casale	Uhde, Casale	Uhde, Casale
		*Ammonium Sulfate	525 tons						
		*Ammonium Nitrate	325 tons						
IRELAND									
Irish Refining	Whitegate	Refinery	32,000 bbls	$33,000,000	Approved	1959	.....	.....	.....
Esso Petr. (Ireland) Caltex (Ireland) Shell Mex., B. P.			30,000 bbls	.....	Under Constr	Summer 1959	.....	.....	Lummus
ITALY									
Asiende Colori Nazionali Affini	Milan	*Phthalic Anhydride	10,000 tons/yr	.....	Engineering	Late 1959	Monte-catini	Badger Mfg	Badger Mfg
	Cengio	*Phthalic Anhydride	22,000,000 lbs	.....	Engineering	Early 1960	Badger Mfg	Badger Mfg	Badger Mfg
Asfalti Bitumi Cementie Derivati, S.A.	Ragusa	Polyethylene	25 tons	.....	Under Constr	.....	.....	BASF	.....
Azienda Nazionale Idrogenazione Combustibil	Ravenna	Styrene Monomer	14,000 tons/yr	.....	Under Constr	.....	Koppers	SBA	SBA
		Butadiene	22,000 tons/yr	.....	Engineering	Fall 1959	Houdry	Catalytic	.....
		Ethylene	.....	.....	Under Constr	.....	Koppers	ANIC	.....
Distilleria Italiana	Milan	Butanol	11,000 tons/yr	.....	Engineering	.....	Hoechst	Uhde	Uhde
Ftalital, S.p.a.	Italy	Maleic Anhydride	2,200,000 lb/yr	.....	Engineering	.....	S D	S D	.....
I.R.O.M.	Venice	Hydrofiner	6,500 bbls	.....	Under Constr	1959	.....	SNAM	SNAM
Mobil Oil Italiana	Naples	Cat Reforming	9,000 bbls	.....	Under Constr	.....	.....	CTIP	CTIP
		Cat Hydrodesulfurization	10,000 bbls	.....	Under Constr	.....	.....	CTIP	CTIP
		Lube Exp.	.....	.....	Under Constr	.....	.....	Staff	Staff
		Exp Polypropylene	.....	.....	Planning	1959	.....	.....	.....
Montecatini Societe Generale per l'Industria Mineraria Chimica	Ferrara	Exp. Formaldehyde	135,000,000 lbs/yr	$ '00,000	Under Constr	.....	.....	.....	.....
	Castellanza	Exp. Formaldehyde	70C,000 tons/yr	$95,000,000	Under Constr	1962	.....	.....	.....
	Brindisi	*Petrochemical							
Sincat	Priolio, Sicily	*Ammonia	240 Metric Tons	.....	Under Constr	1959	Tex aco	Foster Wheeler	.....
		Ethylene	.....	.....	Engineering	1959	S & W	S & W	.....
		Treating	.....	.....	Engineering	1959	.....	S & W	.....
Snia Viscosa	Varedo, near Milan	Carbon Disulfide	.....	.....	Under Constr	1960	Food	.....	.....
Wtanic Petrolifera	Livorno	*Naphtha Stabilizer and Splitter	11,000 bbls	$720,000	Engineering	Late 1959	.....	Esso	CTIP
Union Carbide Societa Edison S.A.	Sicily	*Polyethylene	15,000 tons/yr	.....	Under Constr	1959	.....	.....	.....
NETHERLANDS									
B. F. Goodrich & Algemene	Arnheim	Butadiene	.....	.....	.....	Mid 1959	.....	.....	.....
Kunstzijde Unie N.V.	.....	Styrene	.....	.....	.....	.....	.....	.....	.....
Esso Nederland	Rotterdam	Refinery	100,000 bbls	$50,000,000	Under Constr	Summer 1960	Esso	Esso	Badger N.V.
NORWAY									
Standard (N.J.)	Oslo Fjord	Refinery	40,000 bbls	$30,715,000	Engineering	Late 1960	Esso	Esso	Bechtel
PORTUGAL									
Ammoniaco Portugues	Esterreja.	*Ammonium Sulfate	220 tons	.....	.....	.....	.....	.....	.....
Sociedada Portuguesa de Petroquimica Sarl	Lisbon	*Ammonia	185 tons	.....	Planning	.....	Uhde-Texaco	Uhde-STEC	Uhde-STEC
		*Hydrogen	1.5 Mmcf	.....	.....	.....	.....	.....	.....
		*Fuel Gas	11 Mmcf	.....	.....	.....	.....	.....	.....
RUMANIA									
Maschimport	.....	*Formaldehyde	100 tons	.....	.....	.....	.....	Uhde	Uhde
Rummanian Govt.	Teleajen	Lube Oil	.....	.....	.....	.....	.....	.....	.....
		Natural Gas Treating	.....	.....	.....	.....	.....	.....	.....
	Borzesti	Petrochemical	.....	.....	.....	.....	.....	.....	.....
	Onesti	Synthetic Rubber	.....	.....	.....	.....	.....	.....	.....
SCOTLAND									
British Hydrocarbon Chemicals	Grangemouth	Polyethylene	25,000,000 lbs/yr	.....	Under Constr	1959	Phillips	S & W	.....
		*Ethylene	70,000 tons/yr	.....	Engineering	1960	.....	S & W Ltd	S & W Ltd
		Cumene	.....	.....	Engineering	Mid 1959	Mid-Centry	S D	S & W Ltd
		Phenol	.....	.....	Under Constr	1959	Distillers	S & W Ltd	S & W Ltd
		*Gasoline Treater	.....	.....	Under Constr	April 1960	.....	Lummus	Lummus
British Petroleum	Grangemouth	Copper Chloride	2,000 bbls	.....	Complete	.....	.....	Power Gas	Power Gas
		Kerosine Treating	2,000 bbls	.....	Complete	.....	.....	Power Gas	Power Gas
		Deethanizer	625 bbls	.....	Complete	.....	.....	Power Gas	Power Gas
		*Polyethylene	25,000,000 lbs/yr	.....	Under Constr	Mid 1959	Phillips	S & W	S & W Ltd.
		Ethylene	70,000 tons/yr	.....	Under Constr	Mid 1960	.....	.....	S & W Ltd.
		Cumene	.....	.....	Under Constr	Late 1959	Mid-Century	SD/S&W Ltd	S & W Ltd.
		Phenol	.....	.....	Under Constr	Late 1959	Distillers	S & W Ltd.	S & W Ltd.
		Gasoline Treater	.....	.....	Under Constr	Early 1960	BP	Lummus	Lummus
SOUTH AFRICA									
Caltex	Durban	Refinery	.....	.....	.....	.....	.....	.....	.....
Standard Vacuum Refg.	Durban	*Exp Refinery Powerformer	.....	.....	Complete	.....	.....	.....	.....
		Hydrofiner Boiler Plant							
SPAIN									
Caltex	Cartegena	*Two Stage Crude	35,000 bbls	.....	Engineering	Late 1959	.....	Foster Wheeler	Foster Wheeler
SWEDEN									
A. Johnson & Co.	Sweden	Refinery Exp.	.....	.....	Under Constr	.....	.....	Bechtel	Bechtel
Stockholm Gas & Water Works	Stockholm	Cat Oil Gasification	4 Mmcf	.....	Under Constr	Mid 1959	Power Gas	.....	Power Gas
TURKEY									
Badische Anilin and Soda Fabrik	Kutahya	Ammonium Sulfate	60,000 tons/yr	$20,000,000	Under Constr	.....	BASF	BASF	.....
		Sulfuric, Nitric Acid	50,000 tons/yr						
Mobil Overseas, Shell, Caltex BP	Mersin	Refinery	65,000 bbls	$48,000,000	Under Constr	.....	.....	Foster Wheeler	Foster Wheeler

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 235

Look to..

Vogt



CATALOG F-10
Vogt stainless and alloy steel materials are shown in their application to specific types of piping products in this 432 page catalog.
Write for a copy on your company letterhead. Address Dept. 24A-FPR.

FOR FORGED STAINLESS AND ALLOY STEEL

Valves, Fittings and Unions

IN STOCK AND READY TO GO!

BE SURE to consult the new Vogt Catalog F-10 when in need of top quality forged stainless and alloy steel piping products for severe operating conditions.

The complete Vogt line includes sizes and types to fit your process requirements with high resistance to corrosion, complete freedom from product contamination, and long service life.

HENRY VOGT MACHINE CO.
Louisville 10, Ky.

SALES OFFICES:
New York, Chicago, Cleveland, Dallas, Camden, N.J., St. Louis, Charleston, W.Va., Cincinnati

KOPPERS

on-the-spot availability of rings keeps your lines "on stream"

Dependable performance in all oil and gas applications

Koppers Piston Rings are now available in the field in a complete range of materials and a wide selection of types and sizes for every application in the oil and gas industry.

To gain trouble-free performance, lower operating costs and less frequent down-time, select Koppers Piston Rings—the choice of many original equipment manufacturers.

Koppers Piston Ring dependability, in even the most rugged applications, is backed with 38 years of experience in manufacturing rings of predictable performance.

If you have a ring problem, consult your Koppers field agent or write: KOPPERS COMPANY, INC., Piston and Sealing Ring Department, 4907 Scott Street, Baltimore 3, Maryland.

Send now for Koppers recommended Piston Ring Set-Ups applicable to the engines which you operate.

KOPPERS Sales Offices and Agents in these convenient locations:

Koppers Co., Inc.
District Sales Office
318 N. Pearl St.
Dallas 1, Texas

Lynn Elliott Co.
371 M & M Bldg.
Houston 2, Texas

Tri-State Industrial
Supply Company
520 Hawkins Way
El Paso, Texas

Nolan Sales Corp.
421 N. Cincinnati St.
Tulsa 20, Oklahoma

D. G. Silvey Co.
316 E. Kings Highway
Shreveport, Louisiana

Sample Bros.
2010 Big Bend Blvd.
St. Louis 17, Missouri

Sample Bros.
6315 Brookside Plaza
Kansas City 13, Missouri

KOPPERS

AMERICAN HAMMERED® INDUSTRIAL PISTON RINGS

Engineered Products Sold with *Service*

For more data on advertised products, use Readers' Service Cards, last page.

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Turkish Government..	Istanbul	Natural Gasoline	.....	.....	Planning	.....	.....	.....	.....
UNION OF SOUTH AFRICA									
Standard-Vacuum....	Durban	Refinery Exp.	25,000 bbls	$9,000,000	Complete	.....	.....	Foster Wheeler	Foster Wheeler
		Powerformer	.....	.....	.....	.....	.....	.....	.....
		Hydrofiner	.....	.....	.....	.....	.....	.....	.....
		Steam	.....	.....	.....	.....	.....	.....	.....
YOUGOSLAVIA									
Yougoslav Government	Sisak	Topping and Cat Reforming	15,000 bbls	$5,400,000	Planning	1963	.....	Inst. Pet., Zagreb	Staff
		Ammonia	120/tons	$11,000,000	Planning	1963	Foster Wheeler	.....	.....

Near East

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EGYPT									
Anglo-Egyptian Oilfields	Suez	Cat Reformer	2,300 bbls	.....	Projected	.....	.....	.....	.....
Egyptian Chem. Ind., KIMA S.A.E.	Aswan	Ammonia	315 tons	.....	Under Constr	1960	BASF	BASF	BASF
Egyptian Govt.....	Suez	Power	10,000 Kw	$2,200,000	Planned	1959	.....	.....	.....
		Atmos. Distl., Vac. Distl. & Lube Oils	20,000 bbls	$7,000,000	Planning	1960	.....	.....	.....
		Cat Reformer	3,000 bbls	$2,700,000	Planning	1962	.....	.....	.....
		Hydrodesulfuriser	2,700 bbls	$720,000	Planning	1962	.....	.....	.....
		Lube Oils	.....	$9,000,000	Planning	1963	.....	.....	.....
	Alexandria	Atmos. & Vac., Distl.	10,000 bbls	$1,400,000	Planning	.....	.....	.....	.....
	Cairo	Atmos. Distl. & Vac., Distl.	10,000 bbls	$1,400,000	Planning	.....	.....	.....	.....
IRAN									
Iran Government.....	.....	*Nitrogen	30,000 tons/yr	$30,000,000	Planning	.....	Montecatini	.....	.....
IRAQ									
Iraq Government.....	Baghdad	Refinery Exp.	4[illegible],000 bbls	$11,000,000	Under Constr	1959	Esso	Foster Wheeler	Foster Wheeler
		Powerformer	5,000 bbls	.....	.....	Sept. 1959	.....	Foster Wheeler	Foster Wheeler
		Kerosine Treating	5,000 bbls	.....	.....	Sept. 1959	.....	Foster Wheeler	Foster Wheeler
		Synthesis Gas	121 tons	.....	Under Constr	.....	.....	Foster Wheeler	.....
	Qaiyarah	Refinery Revamp Crude Topping; Vacuum Distl.; Thermal Cracking Asphalt	7,500 bbls	.....	Planning	Late 1959	.....	.....	.....
ISRAEL									
Fertilisers & Chemicals	Haifa Bay	Ammonia Exp. Fertilisers	50 tons	$5,000,000	Engineering	1959	.....	.....	.....
KUWAIT									
Kuwait Oil.....	Mina al Ahmadi	Hydroboon Platformer	4,070 bbls	.....	Complete	.....	UOP	Procon	Bechtel-Kuwait
		Prefractionator	7,300 bbls	.....	Complete	.....	UOP	Procon	Bechtel-Kuwait
NEUTRAL ZONE									
Getty Oil Co.....	Netral Zone	Crude Stripping	50,000 bbls	$2,000,000	Complete	.....	.....	Parsons	Parsons
PAKISTAN									
Pakistan Industrial Dev.	Frnchanj, Pakistan	Ammonia	225 tons	$30,000,000	Engineering	1961	Kobe Steel	Chemico	Chemico
		Urea	375 tons						
SAUDI ARABIA									
Arabian American Oil.	Ras Tanura	Alkylation	1,210 bbls	$6,980,000	Under Constr	Mid 1959	Kellogg	Kellogg/Staff	Staff
		LPG	1,500 bbls	$1,025,000	Engineering	1961	Kellogg	Staff	Staff
SYRIA									
Syrian Government...	Homs	Refinery	20,000 bbls	$14,000,000	Planning	August 1959	Technoexport Prague	Technoexport Prague	Technoexport Prague

Far East

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
HONG KONG									
Hong Kong & China Gas	Hong Kong	Cat Oil Gasification	1.5 Mmcf	.....	Under Constr	Autumn 1959	Hercules	Power Gas	Power Gas
INDIA									
Alkali & Chemical of India	India	Polyethylene	.....	$6,300,000	Under Constr	1959	I C I	.....	Simmon Carves
Indian Government...	Assam	Refinery	15,000 bbls	$17,000,000	Under Constr	.....	.....	Rumanian Government	Rumanian Government
Sahu Chemicals.....	Varanasi	*Ammonium Chloride	120 tons	.....	Under Constr	1959	Uhde	Uhde	Uhde
		Soda Ash Fertilizer	120 tons	.....	Under Constr	1959	Pintsch/Bamag	Pintsch/Bamag	Pintsch/Bamag
		Ammonia	120 tons	.....	Under Constr	1959	John Thompson	CECIP	John Thompson
Standard Vacuum....	Bombay	Asphalt	125,000 tons/yr	$2,500,000	Under Constr	1959	.....	Parsons	Parsons
INDONESIA									
Indonesian Government.....	Palembang, Sumatra	*Urea Fertilizer	330 tons	.....	Under Constr	.....	.....	Foster Wheeler	Foster Wheeler
JAPAN									
Asahi-Dow.....	Kawasaki	Styrene Monomer	50 Metric tons	$4,150,000	Under Constr	Dec., 1959	Dow	Dow	Dow
Asahi Chemical Industries	Nobeoka	*NH, Synthesis Gas	50 Metric Tons	$3,670,000	Under Constr	Nov 1959	Texaco/Chemico	Chemico	Chemico
Daikyo Oil.....	Yokkaichi	Topping & Vacuum	30,000 bbls	.....	Under Constr	Mid 1959	.....	J G C	J G C
Furukawa Chemical Industries	Japan	Polyethylene	.....	.....	Under Constr	1959	Standard (Ind.)	.....	.....
Idemitsu Kosan.....	Tokuyama	Unifiner	6,000 bbls	$1,450,000	Complete	.....	UOP	UOP; J G C	J G C
		*Topping	35,000 bbls	$4,000,000	Complete	.....		Fujinagata Shipyard	Fujinagata Shipyard
		*Platforming	5,000 bbls	.....	Planning	Mid 1960	UOP	UOP/JGC	.....
Japan Synthetic Rubber	Yokkaichi	Butadiene & GR-S Rubber	45,000 tons/yr	$30,000,000	Under Constr	1959	Houdry Esso Goodyear	Blaw-Knox; Catalytic; Chiyoda	Chiyoda

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 236

CONSTRUCTION BOXSCORE—*Continued*

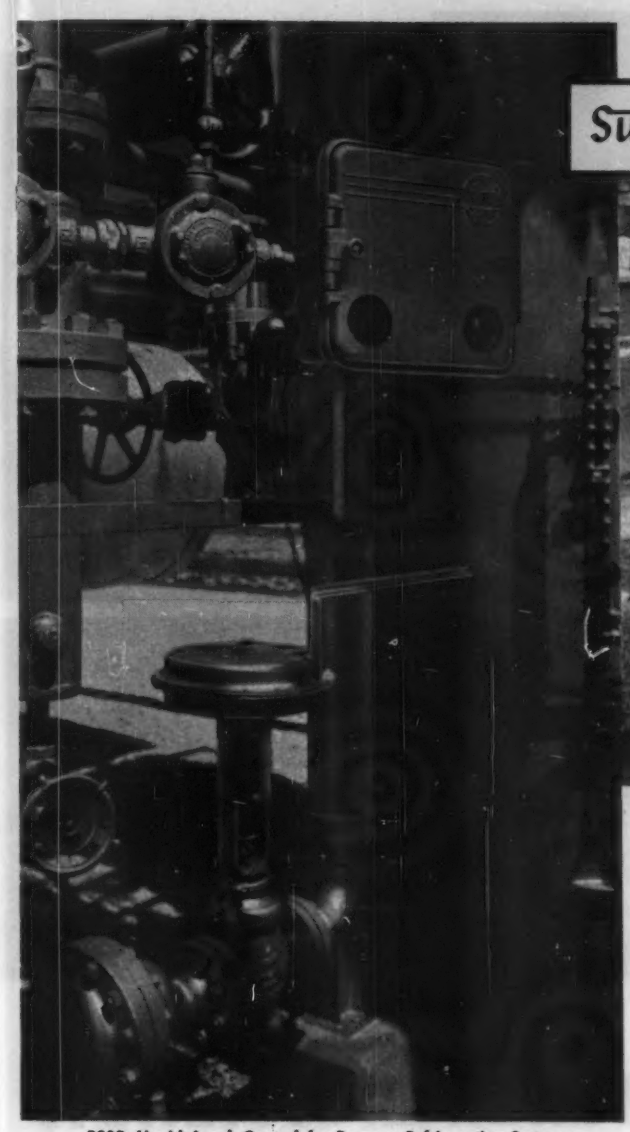
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Koa Oil	Iwakuni	F C C	5,500 bbls	.....	Engineering	Early 1960	UOP	UOP/JGC	.....
		Delayed Coker (Thermal Cracker Revamp)	4,500 bbls	.....	Planning	1960	UOP	.....	.....
		Vacuum Distl.	8,400 bbls	.....	Engineering	Early 1960	UOP	.....	.....
Kyowa Fermentation Industry Co., Ltd.	.....	*Acetaldehyde	45 tons	.....	Planning	.....	Knapsack-Grieshein	Uhde	Uhde
Maruzen Oil	Matsuyama	Udex	1,800 bbls	$2,200,000	Under Constr	.....	UOP	UOP; J G C	J G C
		Benzene	6,000 tons/yr	.....	.....	.....	UOP	.....	.....
		Toluene	4,000 tons/yr	.....	.....	.....	UOP	.....	.....
		Xylene	4,000 tons/yr	.....	.....	.....	UOP	.....	.....
		Oxidation	20 tons	$4,000,000	Engineering	.....	S D	S D	S D
		Benzoic Acid	900 tons/yr	.....	.....	April 1960	S D	.....	.....
		Phthalic Acid Anhydride	2,245 tons/yr	.....	.....	April 1960	S D	.....	.....
		Isophthalic Acid	5,600 tons/yr	.....	.....	April 1960	S D	.....	.....
		Terephthalic Acid	2,500 tons/yr	.....	.....	April 1960	S D	.....	.....
		*Crude Topping	25,000 bbls	$1,400,000	Under Constr	Mid 1959	.....	Chiyoda	Chiyoda
Mitsui Petrochemical Industries	Iwakuni City	Terephthalic Acid	.....	.....	Under Constr	Sept. 1959	S D	S D	Mitsui Shipbuilding
		Paraxylene	.....	.....	Engineering	Sept. 1959	S D	S D	.....
		Cat Reformer	.....	.....	Licensed	.....	.....	.....	.....
		Paraxylene	.....	.....	.....	Summer 1959	.....	S D	.....
Mitsubishi Petrochemical	Yokkaichi	Ethylene Oxide	13.4 tons	$28,000,000	Engineering	Oct. 1959	S D	S D; Chiyoda	Chiyoda
		Ethylene Glycol	9.2 tons		Engineering	Oct. 1959	S D	S D; Chiyoda	Chiyoda
		*Ethylene	76.7 tons		Complete	.....	S & W	S & W/JGC	JGC/Staff
		*Polyethylene	30.8 tons		Complete	.....	BASF	JGC/Staff	Mitsubishi Shipbuilding & Eng./Mitsubishi Chemical Engrg
Nippon Petrochemicals	Kawasaki	Ethylene	25,000 tons/yr	$16,000,000	Engineering	Spring 1959	S&W Esso	S&W; J G C	S&W; J G C
		Butadiene	5,000 tons/yr						
SBA & Sumitomo Chemical	Niihama City	*Acetylene-Ethylene	.....	.....	Planning	.....	.....	Staff	Staff
Showa Denko KK	Tokyo	Synthesis Gas	121 short tons	.....	Under Constr	1959	Texaco	Foster Wheeler	Foster Wheeler
			121 short tons	.....	Under Constr	1959	Texaco	Foster Wheeler	.....
Showa Yuka	Japan	Polyethylene	.....	.....	Under Constr	Mid 1959	Phillips	Staff/Braun	.....
Toa Nenryo Kogyo	Shimizu	Exp. Powerformer; Hydrofiner; Kerosine Acid treating; Copper Sweetener; Offsite Facilities	43,500 bbls	$12,500,000	Under Constr	.....	.....	.....	.....
Ube Kosan	.....	*Ammonia	100 tons/day	.....	Engineering	Jan. 1960	.....	Chemico	Chemico
KOREA									
Korean Government	Chung-ju	Urea	285 tons	$33,500,000	Under Constr	.....	Inventa-Vulcan	Hydrocarbon, McGraw Vulcan	Hydrocarbon McGraw
	Naju	*Urea	95,000 tons/yr	.....	Engineering	1962	Inventa	Lurgi, et al	Lurgi, et al
TAIWAN (FORMOSA)									
Chinese Petroleum	Kaoshiung	Alkylation	800 bbls	$1,000,000	Complete	.....	Texaco	Badger Mfg	Staff
THAILAND									
Thai Defense Ministry	Bangkok	Refinery	5,000 bbls	$30,000,000	.....	.....	.....	Japanese Fuji	Japanese Fuji

Australasia

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
AUSTRALIA									
Bitumen & Oil Refineries	Sydney	Diesel Unifiner	2,500 bbls	.....	Under Constr	.....	.....	UOP	Staff
		Crude	12,000 bbls	.....	Proposed	.....	.....	Procon	Procon
British Petroleum	Kwinana	Cat Reformer	10,000 bbls	$9,200,000	Complete	.....	.....	UOP Kellogg	Kellogg
Imperial Chemical Industries of Australia & New Zealand	Australia	Polyethylene	5,000 tons/yr	$5,040,000	Under Constr	.....	.....	.....	.....
Shell Oil	Newport	Oil Blending	.....	.....	.....	.....	.....	.....	.....
Shell Refining (Australia)	Clyde	Platformer	6,700 bbls	.....	Under Constr	.....	UOP	.....	Procon
	Geelong	Hydrodesulfuriser	11,000 bbls	.....	Projected	3rd Qtr. 1959	.....	.....	.....
Standard Vacuum	Melbourne	Refinery Revamp	.....	.....	Under Constr	Mid 1959	.....	Fluor	Fluor
	Adelaide	Refinery	30,000 bbls	$30,000,000	Planning	.....	.....	.....	.....
Shell Chemical	Clyde	*Resins, Alkylates	.....	$22,000,000	Planning	.....	.....	.....	.....
PHILIPPINE ISLANDS									
Gulf Oil	Luzon	Refinery	20,000 bbls	$23,000,000	Planning	Late 1960	.....	.....	.....
Shell (Philippines)	Manila	Refinery	.....	.....	Negotiating	.....	.....	.....	.....
Standard Vacuum	Bataan	*Refinery	25,250 bbls	$35,000,000	Engineering	Late 1960	.....	Foster Wheeler	Foster Wheeler
Union Carbide	Melbourne	*Polyethylene	15,000,000 lbs/yr	.....	Planned	1961	.....	.....	.....

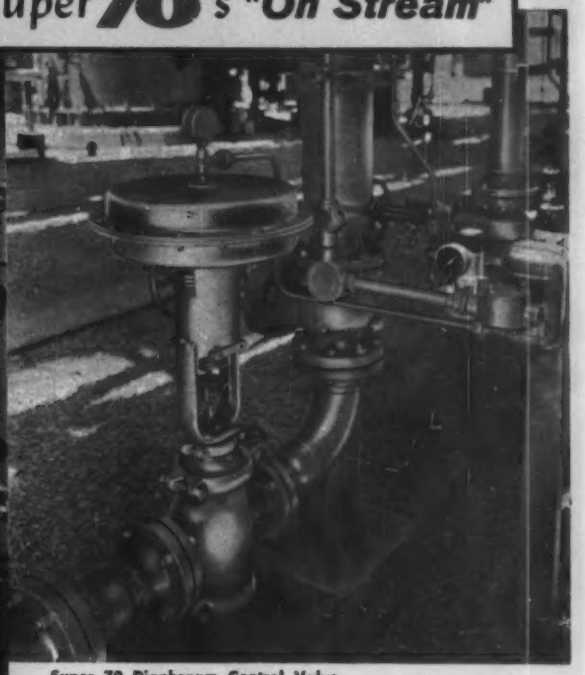
* First appearance in tabulation.

Atlantic—Atlantic Ref. Co.
Austin—The Austin Co.
Badger N.V.—Badger Campriso N.V., Netherlands
Badger Mfg.—Badger Mfg. Co.
B & R—Brown & Root, Inc.
BASF—Badische Anilin & Sod. Fab.
Bechtel—Bechtel Corp.
Blaw-Knox—Blaw-Knox Co.
Braun—C F Braun Co.
Braziliera
Calif. Res.—California Research Corp.
Canadian
Canadian Bechtel
Catalytic—Catalytic Construction Co.
Chemical Projects Assoc.
Chemico—Chemical Construction Co.
CTIP—Compagnia Technica Industria Petroli
Davis Construction
Day & Zimmerman
Devon Palmer
Dortmund
Dresser—Dresser Engineering Corp.
Ehrhart—Ehrhart & Associates, Inc.
Esso—Esso Research and Engineering Co.
Ferguson—H. K. Ferguson Co.
Fijinagata Shipyard
Fisher
Fluor—Fluor Corp.
Food—Food Machinery & Chem. Corp.
Foster Wheeler—Foster Wheeler Corp.
GHH
Girdler—Girdler Construction Division, Chemetron Corp.
Hawaiian Dredging
Heurtey
Hudson—Hudson Engineering Corp.
Hughes
Hydrocarbon—Hydrocarbon Research, Inc.
HWP—Head Wrightson Process, Ltd.
Inst. Pet., Zagreb
Japanese Fuji
JGC—Japan Gasoline Co.
Kaigho
Kellogg—The M. W. Kellogg Co.
Kidde Constr.—Walter Kidde Constructors, Inc.
Kidde Engrs.—Walter Kidde Engineers Southwest, Inc.
Kobe Steel
Kooka Still
Koppers—Koppers Co., Inc.
Leonard—Leonard Construction Co.
Litwin—Litwin Engineering Co.
Lummus—The Lummus Co.
Lurgi—Lurgi G. m. b. H.
Macco—Macco Corp.
McAlpine-Winpey
McKee—Arthur G. McKee Co.
Mitsui Shipbuilding
Montreal, SA
Nofsinger—The C. W. Nofsinger Co.
Olsen—O. L. Olsen Co.
Parsons—The Ralph M. Parsons Co.
Pintsch Bawag
Pooie
Power Gas—Power Gas Corp., Ltd.
Pritchard—J. F. Pritchard Co.
Process Contracting
Procon—Procon, Inc.
Quaker—Quaker Valley Constructors
R & E
S&W—Stone & Webster Engineering Corp., Chemical Division
S&W Ltd.—Stone & Webster Canada, Ltd.
SBA—Soc. Belge de L'Azote et des Produits Chimiques du Marly
SD—Scientific Design
SETAL
SFST—Societe Francais des Services Techniques
SNAM
Simmen Carver
Soc. Chemique—Societe Chimique de la Grande Paroisse
Stamicarbon
Stearns-Roger—Stearns-Roger Mfg. Co.
STEC
Sumner Sollitt—Sumner Sollitt Co.
Swoco—Southwestern Engineering Co.
Technoexport, Prague
Tellepsen—Tellepsen Petro-Chem Constructors
Troco—Refinery Engineering Co.
Uhde—Friedrich Uhde, G. m. b. H.
U.O.P.—Universal Oil Products
Vulcan—Vulcan Cincinnati
Ziegler



BS&B Liquid Level Control for Propane Refrigeration System

Super 70's "On Stream"



Super 70 Diaphragm Control Valve
as Debutanizer Reflux Flow Controller

BS&B

ELECTRO-PNEUMATIC CONTROLS SERVING WARREN'S MONT BELVIEU PLANT

In their Mont Belvieu Fractionation Plant, Warren Petroleum Corporation separates propane, isobutane, normal butane and natural gasoline. Efficient day in, day out operation of this large plant is assisted by BS&B Super 70 Control Valves, Liquid Level Controls and Regulators.

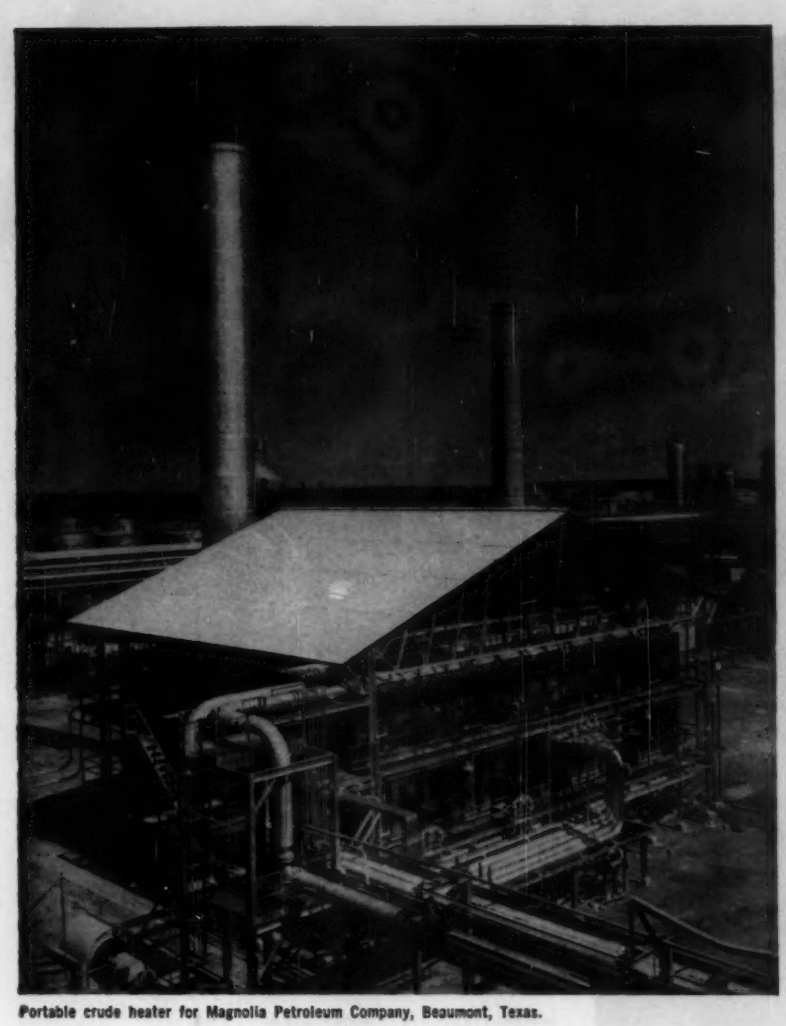
A complete modern electronic control system was designed and installed in Mt. Belvieu for the control of precise product purity. BS&B's level controls and control valves were selected as primary and final control elements, due to their superior performance characteristics and rugged dependability.

BS&B Controls are proving their superiority in service the world over. Specify them on your next job.

BLACK, SIVALLS & BRYSON, INC.

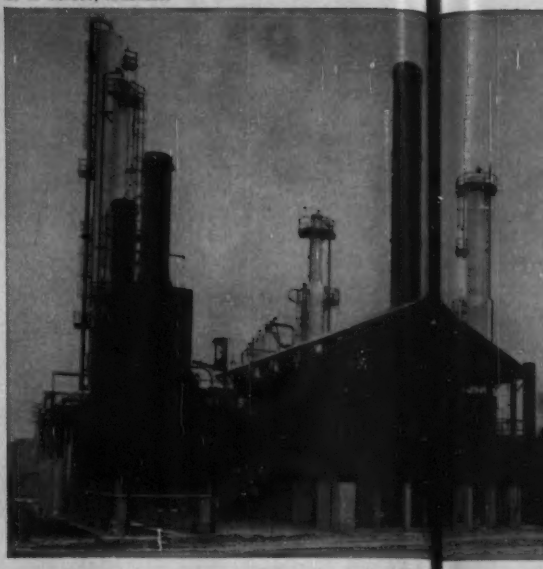
Controls Division, Dept. 4-F7
7500 East 12th Street Kansas City 26, Missouri

For more data on advertised products, use Readers' Service Cards, last page.



Portable crude heater for Magnolia Petroleum Company, Beaumont, Texas.

Ultraformer heater for American Oil Co. at El Dorado, Arkansas.



Platformer and desulphurizer heaters for Shell Oil Co. at Deer Park, Houston, Texas.

HIGHER EFFICIENCY, LUMMUS OIL HEATERS

Lummus designs horizontal and vertical-tube oil heaters to any size, for any process—anywhere in the world

Major refiners confidently turn to Lummus on their important and difficult oil heater jobs.

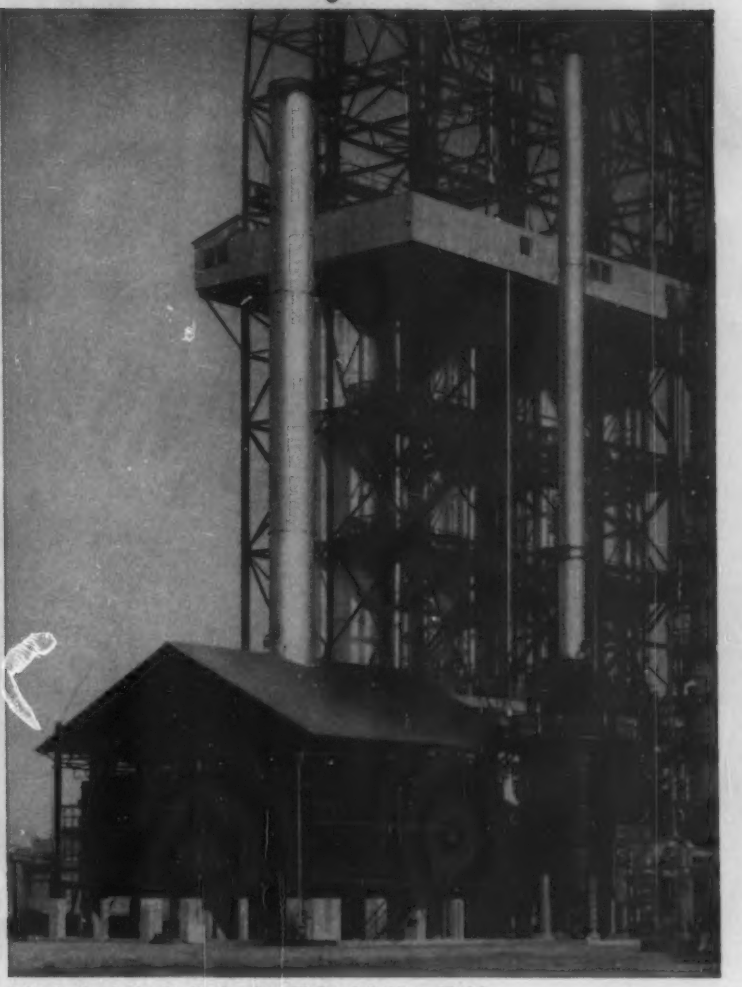
In the last 25 years, the combined capacity of all Lummus oil heaters built has exceeded that of any other company in the world. The reasons: greater durability, more efficient operation, an absolute minimum of days lost to downtime.

Major refiners maintain large engineering and economics staffs who can evaluate the performance of important heating equipment. They buy more Lummus oil heaters because they *know* through statistical comparison that Lummus gives them *more heater per dollar.*

Lummus offers over a quarter of a century of oil heater experience for petroleum refineries, chemical and petrochemical plants. The highly trained engineering staff of the Oil Heater Division is ready in the Lummus New York office to give each job the full benefit of its accumulated know-how in this field.

Lummus oil heaters, of both special and standard design, range from 100,000 to 300,000,000 Btu per hour. As illustrated above, neither size, type nor location of the unit presents a problem to Lummus. Because Lummus offers *every* type of oil heater, you can be sure that we will recommend the *right*

Crude heater for Socony Mobil at Paulsboro, N. J.



Delayed coker heater for the American Oil Co. at Yorktown, Virginia.

MINIMUM DOWNTIME MAKE PREFERRED AMONG MAJOR REFINERS

unit for your needs. Complete Lummus facilities are available world-wide through any of the five international Lummus companies. Equipment is designed in New York, procurement is made through the nearest Lummus international office, and the cost of the job is payable in the currency of the country in which the procurement is handled!

Consult with Lummus on your next oil heater — large or small.

LUMMUS

THE LUMMUS COMPANY, OIL HEATER DIVISION
385 MADISON AVENUE, NEW YORK 17, N. Y.

WASHINGTON, D. C. • HOUSTON • MONTREAL • MARACAIBO • LONDON • PARIS • THE HAGUE

For more data on advertised products, use Readers' Service Cards, last page.

. . . to give you . . .

DEPENDABLE DELIVERIES OF

Natural Gasoline

whatever the grade, whatever the volume

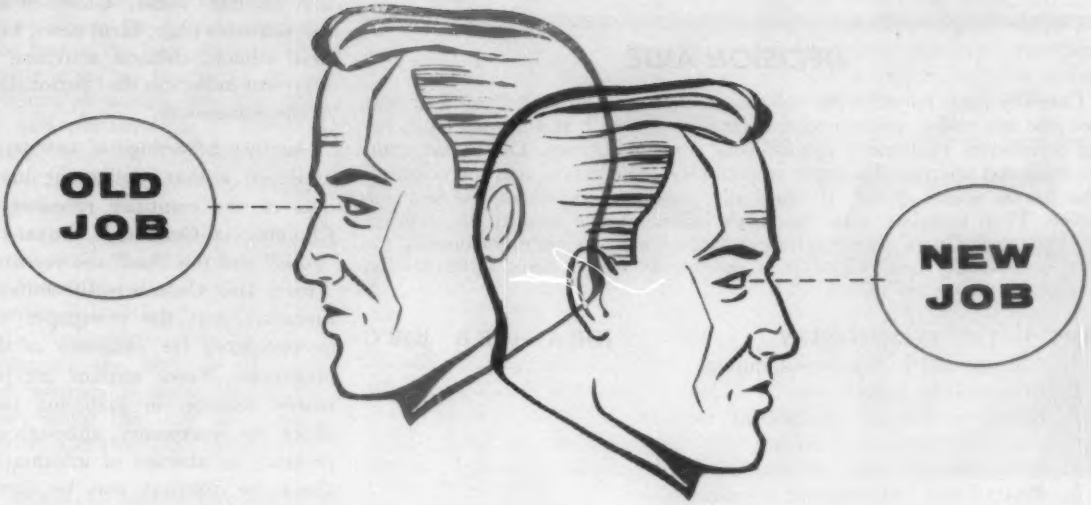
- WHEN you want it,
- WHERE you want it and the
- WAY you want it.

WARREN

PETROLEUM CORPORATION

TULSA, OKLAHOMA • Cable Addresses: STAVOLENE, WARREN

EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WARRENGAS, HOUSTON, TEXAS, SAN PEDRO, CALIF.



Should You Accept That New Job?

One of the most important problems you and your family will ever face is that of changing jobs or selecting between several job offers. At last, here is a good, logical approach to use in making your decision

Charles C. Cleland, Austin State School
Robert F. Peck, The University of Texas, Austin, Texas

ENGINEERS are ordinarily thorough and objective in appraising technical problems, yet they occasionally fail to exercise these analytic abilities when faced with decisions about their own lives. For example, they are often faced with the practical problem of changing jobs or selecting between several job offers.

Often, the choice between jobs is made more difficult when the salary is identical or approximately so. Obviously, therefore, other factors must be given consideration in arriving at a sound final decision. Further, the decision reached is one that not only influences professional or scientific advancement, it usually affects the entire family as well.

Thus, the choice of one position over another calls for extremely careful, objective attention. Yet, partly because few of us change jobs often enough to get "experienced" at it, it is not always easy to approach the decision in an objective, organized manner. However, one practical help has been found for this: the "Decision-Aide," a procedure which executives and professional men have found useful in appraisal of new openings.

This help can earn good will for a company that offers it to prospective employes. The good candidate who is most likely to remain with a firm is the man who has made his choice by a complete, frank analysis of all the pros and cons, *as he sees them.* Consequently, the procedure described here is one that companies can offer to a prospective employe. In this way, the candidate, considering the new job, can weigh its merits from his point of view, and make a decision which will keep him satisfied.

Get the Facts. Let's say for instance, that you are considering one or more job offers. As a first step, you need facts. One initial step in fact-gathering is to secure information from the Chambers-of-Commerce in the city or cities where the

job offers occur. This information is ordinarily supplied gratis and includes data on the economic structure of the community, the weather, educational opportunities, recreational outlets, housing, tax-rates, population statistics and other factors influencing community living.

A further source of facts and information is the community newspaper. Much information about the community can be obtained from a trial subscription of two weeks or a month. This medium should provide a reasonably accurate index to the dominant needs and interests of the community—an important factor to consider if the community may become "home." Classified ads, the woman's page, farm news, business, schools, cultural activities, all represent indices to the "personality" of the community.

Another advantage of newspaper appraisal is that, unlike the handouts of the company recruiter or Chamber-of-Commerce, both the "good" and the "bad" are reported. Thus, the Chamber-of-Commerce literature and the newspaper can be compared for omissions or discrepancies. These sources are primarily relevant in gathering facts about the community, although the presence or absence of information about the company may be significant.

DECISION-AIDE

Consider each job offer on each factor and rank-order 1, 2, or 3. If only two jobs are under consideration, then rank 1 and 2. If only one job is being considered, evaluate it against your present position. The lowest number indicates the most favorable response. On completion, add the columns. The **lowest** score should, if truthfully answered, represent the best job choice. Then compare with the wife's independently ranked list, average the two, and discuss. Since different factors may weigh more heavily for some individuals than others, it is possible to weigh items differentially, using one's own set of values.

PART I THE COMMUNITY	JOB A	JOB B	JOB C
1. Climate and health considerations			
2. Comparative living costs			
3. Resources (human and material) to support community economy			
4. Status of profession in community			
5. Professional, fraternal, and religious organizations considered important to way-of-life			
6. Educational facilities			
7. Recreational outlets			
8. Accessibility to other important cities			
9. Social advantages			
10. Cultural and entertainment facilities			
PART II THE COMPANY			
1. Financial soundness			
2. Growth potential			
3. Quality of management			
a. training			
b. experience			
c. stability of tenure			
4. Growth history			
5. Organization structure			
6. Acceptance of new ideas			
a. research and development facilities			
b. management attitude			
7. Opportunity for professional growth			
a. company sponsored schools			
b. opportunity to work with top people			
c. best use of training and experience			
8. Community acceptance of company			
9. Fringe-benefits			
a. security			
b. social-recreational			
c. income tax blessings			
10. Immediate superior, subordinates, and colleagues			
a. work attitudes			
b. morale			
c. quality of training			
11. Work facilities and conditions			
12. Salary			
13. Promotional potential			
14. Position of company in industry			

Seek the Corporate Image. The next step involves getting information about the company or companies involved. Of primary importance, from a long-range point of view, is the relative position of the company in the industry. For factual evidence on this point, numerous sources are available in university, community, or personal libraries. *Barrons, Dun's Reviews, The Wall Street Journal, Fortune, Nation's Business,* etc., may provide you with a good index to the growth and potential of a company, as well as its current position in the industry.

More immediately relevant information may be obtained through company annual reports, stock quotations, and conversation with former employes. If time and arrangements permit, a visit to the communities and companies involved can be the most helpful of all. When an interview is held on the company's "home grounds," it is worthwhile to take a few extra days, if necessary, in order to talk informally with company people.

If an engineer's club is located in the area, it can provide you with an excellent source of information and

"atmosphere." Here you may learn something of the organizational structure of the company in question.

Two in One. You should keep in mind, however, that there are two organizations for every company. The first is the formal organization which is set up in chart form and designed to specific lines of authority and communication. The other is the "informal," or the organization carried only in the heads of employes.

Meeting and talking informally with individuals—potential co-workers, subordinates, and superiors, may provide you with information about both "organizations." Checking to determine the "fit" of the formal and informal organizations may tell most about the way the company really operates—and who really runs it.

Additional information should be carefully sifted to determine management's receptivity to new ideas, the promotional histories of individuals with similar training and experience, fringe-benefits, and opportunities for continued professional growth. If contact and opportunity to work with top people in the field exist, and are reflected in conversations with employes, it indicates the company's strength in attracting good people. As your conversations shift from lower to higher echelons of management, you should focus your attention increasingly on the broader aspects of the company—policies, objectives, and over-all company attitudes.

Analyze the Facts. Equipped with factual data, you are now in a position to analyze these facts. The "Decision-Aide" checklist is designed with the individual in mind. Although admittedly incomplete, it affords an organized approach to job-choice if truthfully and objectively completed.

Since a decision to move from one location to another frequently involves other people, you could certainly avoid a "one-person" bias by providing your wife with a copy of this checklist for independent ranking. Although the ranking of the company by the wife would be optional, depending on her knowledge of the more technical aspects of the work, her independent ranking of the community should be *a must*. The two independently ranked lists may then be averaged and discussed in the hope that later conflicts may be avoided.

Family Considerations. You must not forget that adjustment to a new job involves more than a congenial working environment. For your wife, it means acquiring, with very little help sometimes, an entirely new set of friends and perhaps basic modifications in the family "life-style." Economic considerations are only one of many factors entering into the adjustment to a new job, and this is particularly true of the scientist or professional person. For a family man, an evaluation of the school system becomes an important issue. In most cities the quality of public schools varies greatly from district to district. Usually, the "best" school is greatly sought; although the most ideal school will be of little value to your children if it is located in a district where living costs exceed your income.

Only you and your wife can know your family way-of-life well enough to predict adjustment to a new job and community. However, if this checklist is approached with the facts in hand, and with sufficient candor, it can help prevent or minimize maladjustment and dissatisfaction arising out of a poor job choice.

This same general logic works just as well in weighing the advantages and disadvantages of job changes via promotion. While usually desirable, a "promotion" can occasionally turn out to be a mistake. Here, or wherever major changes in work or living are involved, it pays to consider all factors.

Important to the Company. A procedure such as the "Decision-Aide" can also be of practical importance to the hiring organization. Scientific and professional personnel are expensive. To aid the individual in the choice process by supplying him with this technique can help reduce turn-over and dissatisfaction due to a hastily reached decision, based on a minimum of facts.

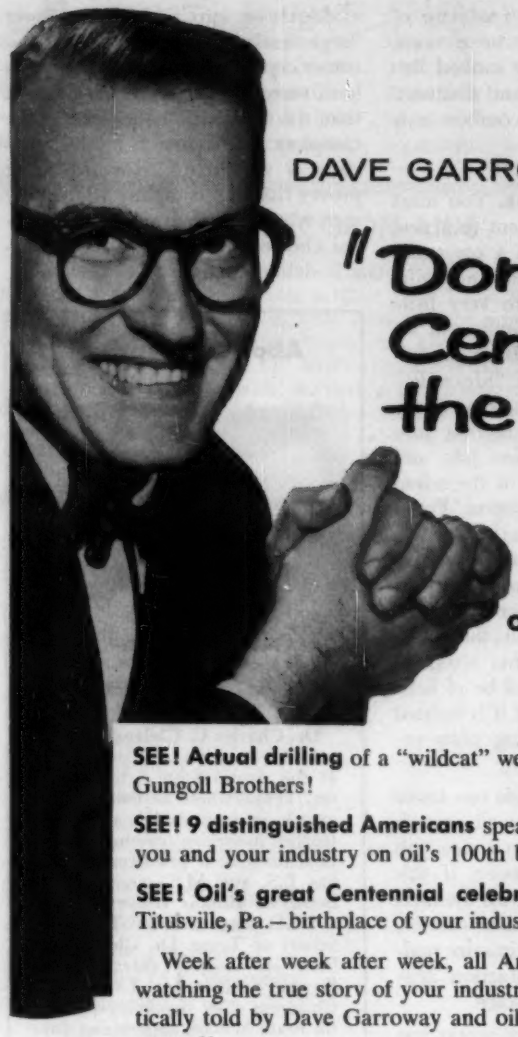
Finally, such an action by a prospective employer is the best possible answer to the accusation that it may be seeking to turn its engineers and executives into mutely compliant "organization men." Instead, it becomes crystal clear that the company both recognizes and accepts the fact that the man will be weighing the company just as much as the company is weighing him. More, it proves that the company wants only men who make their own, independent choices after thoughtful, systematic deliberation.

About the Authors

Cleland Peck

Dr. Charles C. Cleland is director of education and psychology at the Austin State School, Austin, Texas, where he conducts research in mental deficiency and teaches in-service training courses in management practices, etc. He has B.S. and M.S. degrees from Southern Illinois University and a Ph.D. degree from The University of Texas. Dr. Cleland has been an assistant director with Brown Schools for Exceptional Children; chief psychologist, Austin State School; supervising psychologist II, Lincoln State School, Lilcoln, Ill.; lecturer in personnel and industrial management, Illinois Wesleyan University, and advisor, graduate studies, MacMurray College, Jacksonville, Ill.

Dr. Robert F. Peck is an associate professor at The University of Texas, where he directs the Mental Health Demonstration Center, teaches graduate courses, and does research in personality appraisal and character development. Holder of a Ph.D. degree from the University of Chicago, he taught there from 1947 until 1954, when he joined The University of Texas. He also worked in executive appraisal and training at Social Research, Inc., 1947-50, and with Worthington Associates as a vice president, 1950-54. He has conducted executive training seminars at several universities. Dr. Peck is a member of the American Psychological Association and Interamerican Society of Psychology.



DAVE GARROWAY SAYS:

"Don't miss your own Centennial story on the today show! NBC-TV!"

On the air now! A series of dramatic, on-the-spot reports telling the real story of oil and oil's first century.

SEE! Actual drilling of a "wildcat" well by the Gungoll Brothers!

SEE! 9 distinguished Americans speak up for you and your industry on oil's 100th birthday!

SEE! Oil's great Centennial celebration in Titusville, Pa.—birthplace of your industry!

Week after week after week, all America is watching the true story of your industry, realistically told by Dave Garroway and oilmen like yourself.

The TODAY Show has already presented the fabulous International Oil Exposition with oilmen from all over the world. Now you'll meet the Gungoll Brothers and their family and fellow workers . . . "wildcatters" who will take you along to northwest Oklahoma in their search for oil.

You'll share their dreams, their gambles and witness the actual drilling of their well, "Big Dave #1."

On August 27th, you'll see oil's great Centennial celebration, direct from Titusville, Pa.—the birthplace of your industry.

See this exciting new series with your family on June 25, July 2, 16, 30, August 13 and 27. Tell your neighbors and customers to see it, too! See the TODAY Show from 7-9 a.m. on the above dates on your local NBC-TV station!

All summer long, these 9 distinguished Americans will wish a happy 100th birthday to you and your industry:

Gen. A. Gruenther

Norman Rockwell

Donald Douglas

David Sarnoff

Harvey Firestone, Jr.

Frank Pace

Eric Johnston

Gen. Mark Clark

John J. McCloy

The ABCs of Salary Administration

A good program of compensation will spark employe morale and retain management incentive. However, it must be administered with minimum control, and it must grant special recognition for individual performance

Richard B. Blomfield
Union Carbide Corporation, New York City

THERE ARE a great many tangents to this business of enlightened salary administration, but basically it is hinged to company management. It is safe to say that salary administration will never be any better or worse than the company's operating philosophy.

However, let's examine briefly just what a good salary administration will accomplish. Actually, it does four things:

1. It adequately and fairly compensates the personnel.
2. It encourages individual growth and development.
3. It is competitive in the market place.
4. It provides freedom of action for managers to administer salaries at their levels.

Such a program allows for the "economic facts of life," and takes into account the financial condition, potential and profitability of the industry and business.

Two Ways to Administer. Generally speaking, there are two ways to apply a salary administration program. One involves guidance with a minimum of control. The other involves strict control.

The guidance method is the modern way. The strict control method is the old way. Strict salary control is generally administered from a head office through specific rules and regulations or very often by direct action. This results in regimentation of employes and supervisors and takes away the initiative from line Managers.

On the other hand, modern enlightened salary administration implies guidance with a minimum of control. It means top management establishes and communicates the over-all policies and allocates sufficient funds. It also means that the function becomes decentralized and managers are given freedom and authority to act. They utilize it as an important motivating factor in running their departments. They apply salary increases as a constructive instrument in employe relations.

By fixing as much of the responsibility as possible at the point of contact between the employe and his supervisor, modern salary admininstration tends to eliminate "passing the buck." It makes many contributions to a company but in the long run its most important contribution is the creation of employe morale.

In the Past. Let's take a look at the background of salary administration to see how we arrived at where we are today. You may remember efficiency engineering, therbligs, and the other techniques developed during the 1920's. In those days job descriptions for hourly jobs listed a series of exercises performed by an employe. Each hand and finger motion was analyzed. In many cases, these motions became parts of a detailed description.

Rates of pay were set on the basis of these descriptions. This "scientific" approach was applied primarily to hourly-paid employes on production lines.

In many instances, techniques used on hourly employes were transferred to the office. Elaborate schemes were devised for measuring clerical jobs, but the majority of these extensions were shop-learned programs. The time of many executives was devoted to whether Jane actually opened and screened the mail or just opened it.

Those companies addicted to this control approach also made sure that an officer approved Jane's raise. Almost invariably in companies of this type, salary programs

were not discussed with employes. Like the origin of babies, such things were never mentioned.

Methods developed to describe and evaluate production and clerical jobs were inevitably applied to exempt positions. Much use was made of the phrase, "You're evaluating the *job*, not the man."

I mention this background to show that many of the "gimmicks" used in salary administration today are often more of a hindrance than a help. This brings me to one of two problem areas that I wish to touch upon.

"Wage for Age" System. The first of these deals with the indiscriminate use of maturity curves. Maturity curves, as you know, are the ones on which dollars are plotted vertically and age and years-since-basic degree are plotted horizontally. This is nothing new. They are patterned after the European system of "wage for age." While these curves are useful tools to be used as guides to sound salary administration, too often managers use them as a crutch.

These curves should be of value in tracing what you have been doing and also be of help as a reference point. They are of greatest value as a point of departure. The performance of the outstanding individual should never be confused with his age or the number of years since he graduated from college, or indeed, whether or not he even went to college! The controlling factor here must be performance.

When used only as auxiliary guides, however, these curves are useful. They are most revealing during an employe's first ten years on the job. This is the period when the top-flight employe emerges and every effort should be made to locate him and recognize him salary-wise. This means less reliance on system, and more reliance on judgment. This approach is far superior to that based on length of service, age, or type of degree.

Consider Initiative. Another point to consider is that in a rapidly growing organization where the emphasis is on youth, the use of maturity curves as a substitute for enlightened salary administration would tend to stifle initiative. These curves cannot be used exclusively, because such curves fail to take into account the responsibility of the individual, his compensation level, or his contribution. Individual motivation is largely lost if their application becomes controlling.

The popularity of maturity curves has led professional societies, educational institutions, government agencies, and various trade magazines to publish data reputed to show the "truth" about current salaries.

This is where the trouble starts. You are aware of these surveys. Most of you have either used statistics from one of these surveys for your own purposes, or have had one used on you. Remember they should not be swallowed hook, line and sinker by the manager or the employe.

Managerial Restrictions. The second problem area I want to emphasize is the reluctance of some companies to delegate authority in the area of compensation. A plant manager, responsible for several millions of dollars worth of product, may not be allowed to grant an increase to any employe earning over $6,000 a year. In one breath these companies exhort the manager to manage, and at the same time they say, "Hold on, Buster, we'll make the decisions in this area."

This negative approach is one that does not meet the test of good morale. The belief of this manager in himself is certainly not strengthened. Even worse, being human, he might ask a subordinate to cut down on the amount of a well-thought-out and merited increase being proposed so he can approve it.

Under a "guidance" approach, top management would grant the plant manager salary approval authority commensurate with his position. Any necessary control could be exercised through the medium of an over-all budget.

Salary Range Control. In addition to these two problems, there are other dangers and technical pitfalls inherent in close control systems. For example, a company's salary ranges may be set up with a 30 percent spread between minimum and maximum with the midpoint of the range the "control point." Managers are instructed to bring employes to this point on a "raise or remove basis" within a year. Thus, what at first sounds like a very generous program, really is half a loaf at best. This company has controlled its 30 percent merit range to 15 percent.

Another company may have a fine salary structure. An equally elaborate merit rating plan is used where an employe has to make a qualifying score before being considered for a merit increase. However, this management superimposes a bell-shaped curve in each salary range.

Assume that in a certain salary grade the bell-curve distribution only allows three employes at the 90th percentile. Also assume that each of these employes has been there for a considerable period of time. In this example, an employe otherwise fully qualified by merit rating and other requirements could not get a salary increase until one of the three employes moved off the position mentioned.

Perhaps the best way to describe this approach would be "management askew!"

Employe Motivation. These are typical of the problems that arise from using the strict control approach. While a guidance approach will help alleviate these problems, there is another important area that requires management's constant attention. This is the problem of how to motivate the administrative, professional, sales, or supervisory employe who is earning a good salary and doing "enough to get by."

Why should he struggle? Ahead of him are years on a steady job with built-in health, accident and insurance programs, nominal pay increases, and a guaranteed retirement income. This type of individual can be found today in all parts of any organization and at all levels.

His motivation is a tremendous challenge. How is this to be accomplished? Basically we must see that every employe receives the kind of rewards in dignity, appreciation, and compensation that will take into account the economic facts of life and at the same time give him a satisfying and creative career.

One of the obvious answers is individual recognition that accom-

DU PONT *Petroleum Chemicals* NEWS

Number 97 in a Series of Bulletins for the Petroleum Industry

JULY-AUGUST 1959

TEL overseas

How Du Pont services the oil refineries of the world

Key Men In Du Pont Export

WALTER MEES: For the past nine years, Walter Mees, at the left, export manager, has traveled up to 100,000 miles a year helping refiners all over the globe to use Du Pont TEL and other additives efficiently. Holland-born and a graduate of a commercial and technical college in that country, he speaks five languages fluently and understands two more.

Before joining Du Pont in 1950, Mr. Mees had 12 years' experience with the Royal Dutch Shell group, ranging from drilling to marketing to a management position in Venezuela.

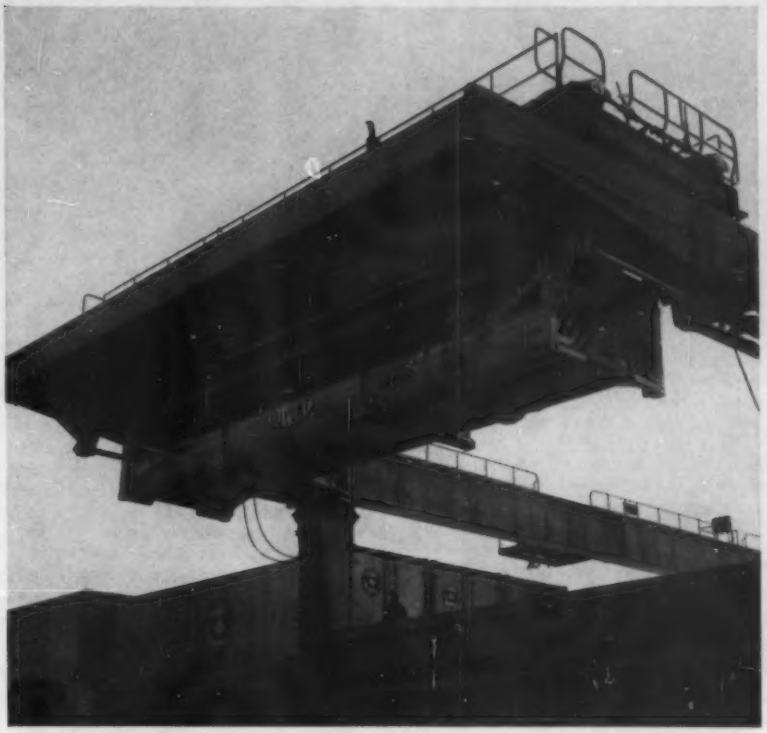
With his broad experience as a producer and marketer of petroleum products, plus his intimate knowledge of world-wide oil operations, Mr. Mees has become well-known for his success in offering Du Pont's extensive services and resources to help solve the problems of oil men on all continents.

RENATO S. CARDOSO, above right, as an export account manager, handles much of the world-wide contact work of the Petroleum Chemicals Division.

Brazilian-born Mr. Cardoso studied in schools in Spain and Portugal before entering Columbia University in New York. He then transferred to the University of Pennsylvania to study chemistry.

He joined the Export Division of Du Pont in 1936, after working for a year at the General Chemical Company. During World War II he served with the Army Chemical Corps and returned to Du Pont in 1946. He was as-

CONTINUED OTHER SIDE



34,000-LB. CONTAINERS like these travel overseas. The one shown here is destined for Puerto Rico. All Du Pont TEL sold overseas is made in the United States but not all ports can receive the containers shown, and drums are used in their place.

Du Pont tetraethyl lead shipments are a familiar sight at Manaus, location of an oil refinery 1000 miles up the Amazon River . . . at Iquitos behind the Peruvian Andes . . . in all of Japan's refineries . . . and at dozens of other refineries throughout the world.

With TEL and with the many other Du Pont petroleum additives sold overseas goes technical service similar to that enjoyed by refineries in the United States.

Generally, the service is of greatest importance. Like helping to design, test and start up TEL blending equipment. Du Pont also trains plant personnel and keeps them up to date on such developments as dry dye eduction and Du Pont's siphon starter.

Besides all this, there's routine servicing concerned with supplying basic technical literature and films and sales promotional material. Also, supervising the unloading of TEL and keeping it under close observation from manufacturing plant to blending plant. We furthermore take part in industry public relations and we cooperate with foreign governments insofar as public health is concerned.

If you'd like to know more about just what services are available and how they are obtained, please address Mr. Walter Mees, Export Sales Manager, Du Pont Petroleum Chemicals Division, Wilmington 98, Delaware.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

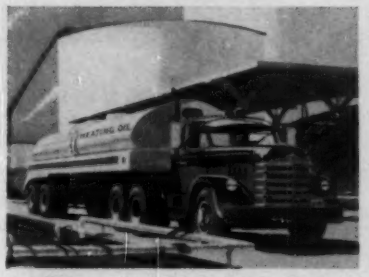
OVER

DUPONT *Petroleum Chemicals* NEWS

CONTINUED **Key Men**

signed to the Petroleum Chemicals Division at the beginning of this year. Mr. Cardoso speaks four languages.

Diesel fuels with FOA-2 and DMD stay stable, show no sludge



Small quantities of DuPont Fuel Oil Additive No. 2 and Metal Deactivator can keep a diesel locomotive's injectors sliding free and its filters unplugged even when a blend of economy grade oils is used for fuel.

Recent field tests in Texas showed that adding 1.5 pounds of FOA-2 and 0.05 pound of DMD per 1000 gallons of oil solved an injector sticking problem plaguing several makes of tractors.

In a second test in the same area, just half the amount of additive solved a problem of filter clogging and injector sticking in truck engines.

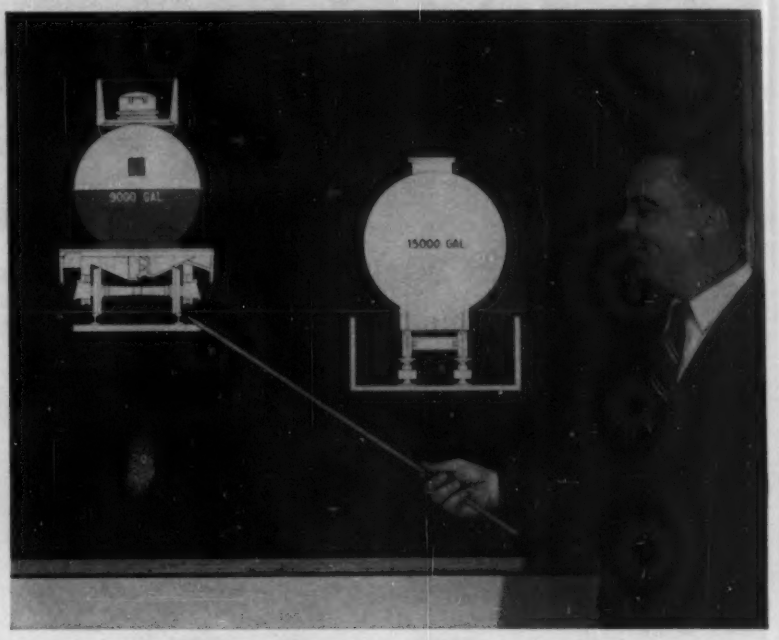
One company with a heavy-duty, high-speed diesel trucking fleet increased the life of its injectors two to three times simply by adding 1.25 pounds of FOA-2 to each 1000 gallons of fuel.

Your DuPont representative – his office is listed below, right – can fill you in on the details of both these DuPont additives. They are sold overseas as well as in the U.S.A.

Neoprene-modified asphalt roads show great promise in tests

Twelve different states are currently helping in tests involving roads laid with asphalt modified with DuPont neoprene synthetic rubber.

The new combination appears to do a better job of holding cover stone in place and preventing weather from breaking through to the roads' bases.



New flannel board gives cues on TEL tank car unloading

To help you evaluate TEL unloading procedures for optimum efficiency, DuPont has prepared a flannel board presentation which can simulate exactly actual plant conditions.

With the kit provided you can duplicate tank car size, size of weigh tank, and unloading line elevation in exact scale.

Calibrated cards show lift in inches Hg, vacuum needed for lift, and vacuum needed to start flow when you must overcome liquid pressure in the tank.

A slide rule shows quickly the rate of flow you can expect with a system, allowing for the variables of height, pipe friction, and pumping force.

If you're looking for a way to present such facts concisely and graphically to a group, contact the DuPont representative nearest you. His office is listed in the box below.

SALES OFFICES

Chicago 3—8 So. Michigan Ave. . . . . RAndolph 6-8630
Cleveland 15—101 Prospect Ave. . . . . MAin 1-3422
Houston 2—705 Bank of Commerce Bldg. . . . . CApitol 5-1151
Los Angeles 17—612 So. Flower St. . MAdison 4-1354
New York 20—45 Rockefeller Plaza . . . . . COlumbus 5-2342
Philadelphia 2—3 Penn Center Plaza. . LOcust 8-3531
Pittsburgh 22—1 Gateway Center . . . ATlantic 1-2933
San Francisco 4—111 Sutter St. . . . . EXbrook 2-1934
Seattle 3—4003 Aurora Ave. . . . . MElrose 2-6977
Tulsa 1—1811 So. Baltimore Ave. . . . . LUther 5-5578
In Canada—DuPont of Canada Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**—Ontario . . . . . HUdson 1-6461
OTHER COUNTRIES: Petroleum Chemicals Division, Export Sales, Wilmington 98, Delaware, PRospect 4-2962.

DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living
. . . *through Chemistry*

Du Pont Tetraethyl Lead and other Petroleum Additives

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-11370

Printed in U.S.A.

panies individual accomplishment. Good company morale is the total of the healthy morale of a group of individuals. This in turn results in employes wanting to identify themselves with the company. In companies that achieve a high degree of identification, competent men are convinced that almost anything is possible in the way of a career.

The First Step. In salary administration the first step to take under an enlighted program is job analysis based upon well-written job descriptions. But an important distinction must be made; descriptions for management and professional jobs require *individual* study.

A repetitive listing of vague generalities will not suffice. Neither will a short-sighted approach which takes into consideration the job without the man.

Just as it is impossible to separate the man from the job in describing his position, it is also impossible not to have him influence an evaluation. When a job such as Research Director is under consideration, the incumbent must be considered. The way he organizes his function will be different from both his predecessor and his successor. By considering the individual we refer to the way in which he shapes his job. This should not be confused with his performance.

Resulting salary schedules should be internally consistent and externally competitive, and have salary ranges that allow for the recognition of individual performance. Salary ranges or grades are referred to by different names in different companies. The names applied to their salary ranges by two companies are particularly revealing. One refers to them as "steps in a motivational ladder." Another calls them "levels of competence."

Two Routes. Individual motivation can also be encouraged by making use of the dual "Manager-Specialist Expert" ladder, or what I prefer to call the *"motivational Y."*

This approach is usually associated with research laboratories. Entering professionals are hired at the bottom of the "Y" at the lower salary ranges. After a few years of experience some are chosen as group leaders and others become research scientists. At this point the individual who becomes a group leader goes into the entry job on the administration arm of the "Y" and may then progress up this arm to Director of Research.

The fledgling research scientist can progress up the professional arm to a job of Senior Research Consultant which should be at a level close to that of Director of Research. This enables a company to recognize that a man can make fully as a great a contribution in the role of professional specialist as he can in the role of administrative manager.

Salary Drawbacks. Up to this point we have been talking about straight salary plans. A straight salary has certain advantages. From the employe's point of view it is a regular source of income that can be relied upon. However, because of progressive income taxes, it is not very effective for developing an estate, providing for retirement, or taking care of an executive's family if he dies or is disabled. Also, salaries are a relatively inflexible charge against earnings which cannot be readily reduced when company profits decline.

Opportunity and incentive or hope of reward must be listed among the forces that have helped to produce the American business system. Therefore, many companies use supplemental compensation programs to increase profits.

By supplemental compensation programs, we mean those that include some form of stock purchase, profit sharing, bonus, restricted stock option, or incentive plan.

How do these programs increase profits? Supplemental compensation does this by:

1. Making available a maximum net return after taxes for the executive at a minimum cost to the company.
2. Tying in executive compensation more closely to profits and to individual executive performance than is possible in straight salary programs.
3. Treating the executive as a partner in the company.
4. Bringing more flexibility into the compensation program so that expenses can be reduced more easily when profits decline.

Executive Roles. The typical executive wears several hats. At one time or another he is an employe, employer, owner, partner, or professional man. In addition, like other employes, he is different from every other employe because of his personality, age, financial resources, and family situation. Because of this, and the heavier tax burden of executives no single form of compensation fits all situations and all executives.

Of course salary is the basic element in all compensation plans. However, other means of compensation are needed to recognize the roles that the corporate executive plays. The complex motives which guide and stimulate his attitudes and actions must also be taken into consideration.

Other means of compensation in addition to salaries and supplemental compensation include various types of benefit plans and perquisities. There is no one best compensation plan for any one size of firm or for any one type of industry. Such programs must be tailored to the individual company, its particular philosophy, and its method of operation.

Supplemental compensation programs stimulate an ownership viewpoint and tend to improve morale.

Many Ways to Give. In the administration of these plans, an executive who is to be the recipient of special compensation should be given a choice of the type of award that best suits his personal situation. He may wish to have his award deferred until after retirement. If so, this should be arranged. His personal situation may be such that an immediate cash bonus would be preferred, or perhaps an award in dividend equivalents. Another recipient may prefer an award in stock with sufficient cash to pay the taxes involved. Wherever possible, such choices should be made available.

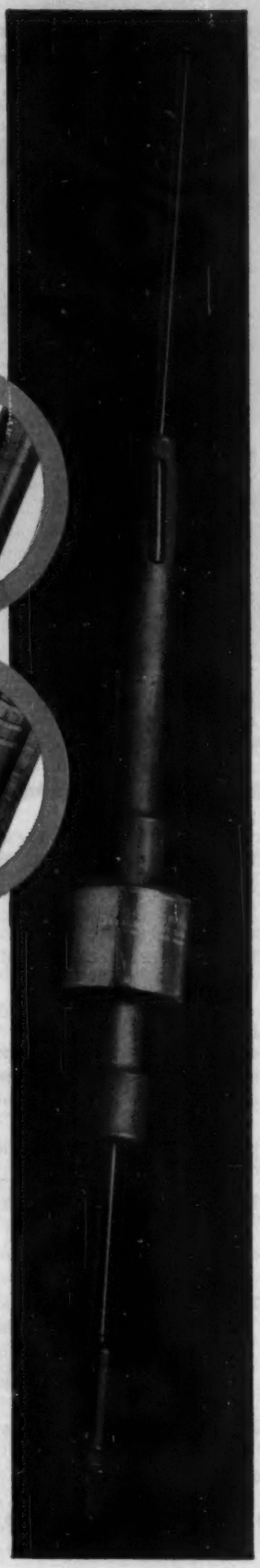
This matter of choice permits an employe to have a voice in his own compensation plan. This, too, will lead to stronger identification with the company and increased morale.

Good Management Vital. Finally, no compensation plan can replace good management. Company officials cannot and ought not to expect a compensation plan to be a substitute for wise leadership—leader-

NEW ELLIOTT TUBE EXPANDERS roll tubes into thick sheets in one pass

Use of **NEW** continuous-rolling technique here—shows uniform seal, with all Keys preserved, and no signs of shear

OLD step-rolling method results in non-uniform surface . . . distortion of Keys where rolls have overlapped



Better seal . . . Smoother surface . . . Much Faster operation

This new concept in tube expanders was developed by Elliott to roll the thickest tube sheets. Using a continuous-rolling method, it eliminates many problems common to step-rolling, may be operated protractively or retractively, saves time, assures uniform, smooth surfaces, avoids annular voids or erratic tube inside diameters, provides better seal.

Accessories

Elliott also makes a complete line of retubing accessories, including both electric and air magnetic Tube Rolling Controls, Tube Gages, Tube Plugs, Tube Cutters, etc.—in addition to a complete line of tube expanders. *Ask for Bulletin Y-52.*

ELLIOTT Company
LAGONDA PLANT, SPRINGFIELD, OHIO
Y9-5

ship that combines financial rewards and intangible satisfactions.

Wise leadership brings to mind what one company president had to say about budgets. His remark has a bearing on enlightend salary administration.

D. L. Yunich, president of L. Bamberger and Company, had this to say: "A budget represents yesterday's planning. If reasons are compelling enough, the budget can be . . . and should be . . . changed. The budget is not a straight jacket intended to freeze all thought and action."

There is more to this business of enlightened salary administration in all of its components. However, most of its goes back to what we said in the beginning about a company's operating philosophy. A salary program is going to be no better or no worse than the over-all philosophy under which a company operates. These philosophies have to be those that permit a company to keep the faith not only with its employes but with stockholders and customers as well.

Originally presented before the American Institute of Chemical Engineers, Atlantic City, March 17, 1959.

About the Author

Richard B. Blomfield is corporate personnel manager for Mack Trucks, Inc. He was previously manager of salary administration for Union Carbide Corp., New York. A graduate of the University of Hawaii, he attended Harvard Law School and has a M.A. degree in personnel administration from Columbia University. Before assuming his present position four years ago, Blomfield was assistant to the general manager of industrial relations, Linde Co. Before that he held a similar position with American Factors, Ltd., Honolulu. An active AMA seminar leader, he is a director and past president of the New York chapter of American Society of Training Directors.

is your PROCESS FLOW HOT?

Honeywell control valves are available for a wide range of temperatures

Whether you're talking about 1200 or minus 450° F, there's a Honeywell automatic control valve for your process flow. The Honeywell valve illustrated—Series 800, Type 11 double seated—is designed to handle fluids at 1200° F. This application requires such features as: welded-in, solid stellite guide bushings . . . stellited guide posts . . . seal-welded seat rings . . . spiral wound, asbestos-filled, stainless steel gaskets . . . high-temperature bolting . . . extended bonnet with fins . . . designed clearances for non-sticking, non-galling operation.

For hot or cold flows . . . or other process flow conditions . . . Honeywell valves are available in a wide range of types and sizes. When you need control valves . . . contact your local Honeywell field engineer. Write for new Catalog C800-1.

MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.

Honeywell

H HONEYWELL *First in Control*

For more data on advertised products, use Readers' Service Cards, last page.

HELPFUL WATER CONDITIONING DATA FROM BETZ

RETURN LINE CORROSION

Causes of corrosion can be readily identified and economically corrected.

Corrosion in the condensate return lines of boiler systems is a frequent problem. To properly prescribe a solution to the difficulty, it is necessary to determine the primary cause of the attack. Prompt elimination of serious return line corrosion is certainly most advisable since necessary maintenance and replacement of pipe and fittings can be quite costly.

By far the most common causes for return line corrosion are the presence of either oxygen or carbon dioxide, or both of these gases dissolved in the condensate. The appearance of the corroded sections will be a good indication of the cause. An attack by carbon dioxide will be characterized by an actual thinning of the metal wall of the pipe, with associated grooving of the metal. Such attack is illustrated in Figure 1.

Figure 1—Grooving attack by CO_2 is shown in this end view of the condensate pipe.

Corrosion by dissolved oxygen will be evident by a series of pits, usually accompanied by deposits of the reddish colored iron oxides. Such attack may be observed in Figure 2. It is not uncommon to see the results of attack which is due to both oxygen and carbon dioxide. The appearance of such sections will have the combined characteristics of oxygen pitting and carbon dioxide corrosion grooving.

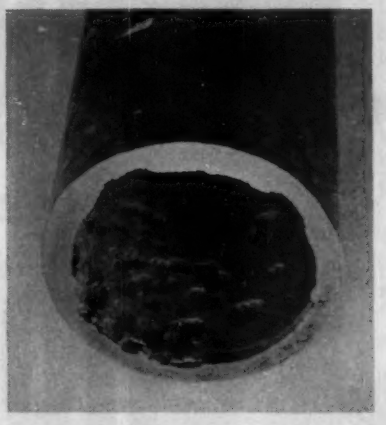


Figure 2—Oxygen pitting attack, distinctly different from CO_2.

Oxygen Attack

Oxygen in steam and condensate may originate directly from the boiler feedwater or may enter at various points in the condensate system. Boiler water makeup will contain appreciable quantities of dissolved oxygen, especially if taken from a surface supply. Since the solubility of dissolved oxygen decreases with increasing temperature, when the feedwater undergoes an increase in temperature in the boiler itself, the dissolved oxygen will be liberated and passed over with the steam. This fact makes the use of an open or deaerating heater of utmost importance in good engineering design of a boiler plant. With such an installation, the major portion of the oxygen in the water will be removed before the water enters the boiler.

The use of an open or deaerating heater removes the oxygen by mechanical deaeration of the boiler feedwater. Since mechanical deaeration is not successful in removing 100% of the dissolved oxygen present, the feed of a chemical deaerant is economically justified to assure that the last traces of the dissolved oxygen are removed. Ordinarily, sodium sulfite (Na_2SO_3) is used for this purpose.

Recently, hydrazine (N_2H_4) has been applied to achieve oxygen removal. The use of hydrazine is usually confined to high pressure installations where the concentration of dissolved solids is critical. Unlike sodium sulfite, hydrazine does not increase the solids of the boiler water.

Oxygen attack can take place not only due to inefficient deaeration of the feedwater, but also through the possibility of oxygen leakage into the condensate. Air infiltration can be expected at condensate pumps, or other points in the system where air may come in contact with the condensate. This potential difficulty can be checked by conducting dissolved oxygen tests on the condensate itself. If it is determined that oxygen is present in the condensate, appropriate mechanical steps can be taken to eliminate or minimize oxygen infiltration.

Carbon Dioxide Attack

Carbon dioxide is the most prevalent cause of return line corrosion, and its source is primarily the feedwater. An open or deaerating heater will remove any free carbon dioxide from the feedwater, but such removal will not eliminate the presence of carbon dioxide in the steam. Since bicarbonates and carbonates present in boiler feedwater will undergo decomposition at elevated temperatures to form carbon dioxide, the result of this decomposition is the chief source of carbon dioxide in the steam. The reactions are as follows:

(1) $2NaHCO_3 + \text{heat} \rightarrow Na_2CO_3 + CO_2 + H_2O$

bicarbonate + heat → carbonate + carbon dioxide + water

(2) $Na_2CO_3 + H_2O + \text{heat} \rightarrow 2NaOH + CO_2$

carbonate + water + heat → hydroxide + carbon dioxide

While reaction (1) will proceed to 100% completion, the decomposition indicated in reaction (2) proceeds to only about 80% completion. All other things being equal, the higher the carbon dioxide content of the steam, the greater will be the corrosion potential. The severity of the anticipated attack may be roughly estimated by conducting

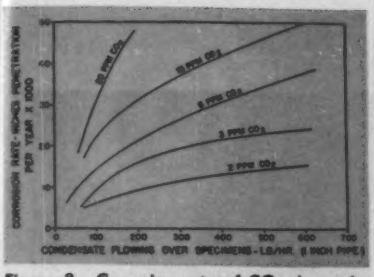


Figure 3—Corrosion rate of CO_2 depends on its concentration and flow rate. Note the drastic rate increase at concentrations above 6 ppm CO_2.

the phenolphthalein and methyl orange alkalinity determinations on the boiler feedwater. In some cases a carbon dioxide concentration as low as 6 ppm may cause a troublesome corrosion problem in the return piping.

However, in addition to the carbon dioxide concentration of the steam, there is one other important consideration in anticipating the severity of corrosion due to carbon dioxide. That consideration is the total pounds of carbon dioxide. Figure 3 clearly illustrates this point. It should be noted that with a carbon dioxide concentration of 6 ppm or above, the rate of corrosion increases rapidly as the rate of flow increases. Another factor which can materially influence the severity of carbon dioxide attack is the possibility of stratification. This leads to a higher rate of attack than expected for the particular flow rate and concentration of carbon dioxide.

Since the carbon dioxide contamination results from an actual breakdown of the carbonate and bicarbonate alkalinity of the feedwater, deaerating practices will be ineffective in reducing the corrosion potential due to this gas. Effective reduction of the corrosion potential may be achieved by external treatment of the feedwater or makeup water to reduce the bicarbonate alkalinity thereof. Such external treating facilities include lime-soda, and lime-gypsum softening, which ordinarily reduce the alkalinity to the 50-60 ppm range. It is advisable, from the standpoint of reducing carbon dioxide corrosion to maintain the softener effluent alkalinity in the carbon-hydrate form, rather than in the form of bicarbonate-carbonate. Other external methods that can be employed to reduce bicarbonate alkalinity to a very low level include acid feed, hydrogen zeolite softening, and dealkalization.

Neutralizing and Filming Amines

When external softening cannot produce a sufficiently low carbon dioxide concentration of the steam, or when the expense for such external treating facilities is not justified, excellent protection from attack can be achieved with the use of neutralizing amines or filming amines.

Neutralization of carbon dioxide can be safely accomplished by certain volatile amines. These amines, when fed to a boiler, volatilize with the steam and combine with the carbon dioxide to neutralize its acidity. Since they react directly with carbon dioxide, the quantity required is proportional to the carbon dioxide content of the steam. Where large amounts of carbon dioxide are present, costs can become excessive.

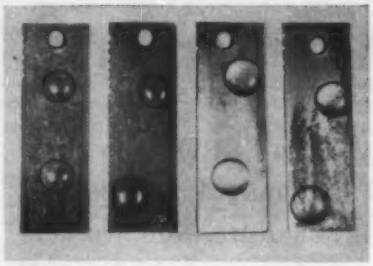


Figure 4—Non-wettability of amine film.

The filming amines function by laying a non-wettable film of monomolecular thickness over the metal surfaces, which is impervious to water. Since the film prevents the water from reaching the metal surface, attack is prevented. The quantity required is independent of the carbon dioxide concentration, and therefore is a more economical treatment particularly where high concentrations of this gas are present. The film forming amines are also effective when oxygen is present in moderate amounts. Figure 4 illustrates the water repellency of the amine film.

Summary

1. Oxygen and carbon dioxide are the chief causes of return line corrosion.
2. Attack by dissolved oxygen is characterized by pits and build-up of deposits of iron oxides.
3. Attack by carbon dioxide is characterized by grooving and actual thinning of the metal pipe walls.
4. Combined attack by oxygen and carbon dioxide will have the characteristics of each.
5. Oxygen attack can be stifled by efficient chemical and mechanical deaeration.
6. Carbon dioxide attack can be inhibited by external reduction of alkalinity and/or use of filming or neutralizing amines.

NEED NOT BE A PROBLEM

A number of factors must be considered on an *individual plant basis* to determine the best way to overcome a return line corrosion problem. Continuing research and development by BETZ LABORATORIES on this important subject has led to a better understanding of the effect of different variables, as well as provided increasingly effective control methods. A BETZ Field Engineer will be happy to discuss your return line corrosion problem and suggest result-producing ways to overcome it. Why not take steps to call him in *now* while you're thinking about it?

BETZ LABORATORIES, INC.

Gillingham & Worth Streets • Phila. 24, Pa.

■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

For more data on advertised products, use Readers' Service Cards, last page.

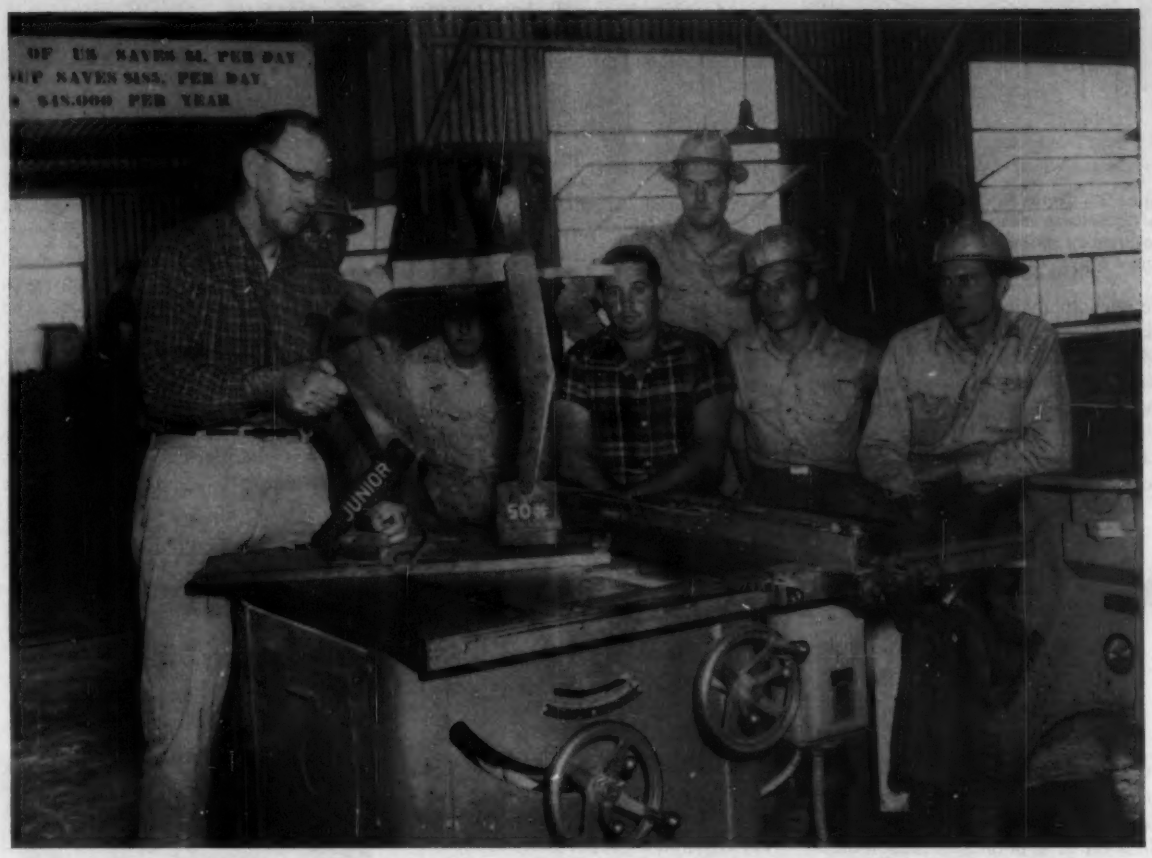


FIGURE 1—J. F. (Chief) Cole, mechanical foreman, conducts a "tool box" session for his employes at American Oil's El Dorado, Ark., refinery. His talks this time is on the proper way to lift weights. The demonstration includes a simple homemade gadget which shows the strain on a man's back unless he keeps it straight and lifts with his legs.

Put Safety on a Personal Basis

Accidents were increasing at Amoco's El Dorado plant until management discovered that only 4.3 percent of all injuries was due to equipment failure. Now workers at that refinery are five times safer at work than off the job

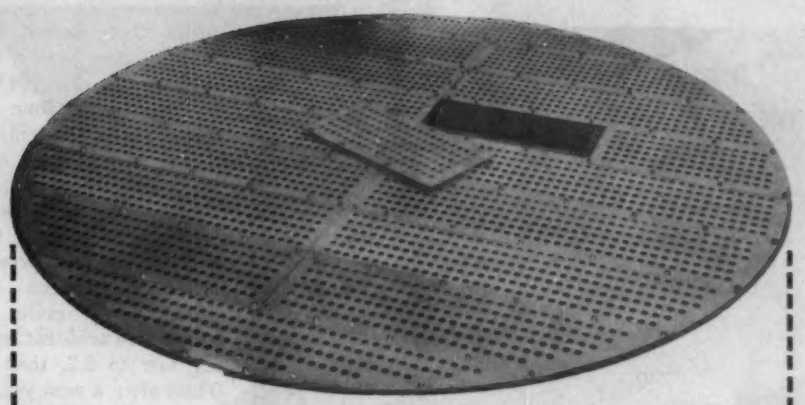
J. B. Hamblen
American Oil Company, New York

A RECENT ISSUE of the *El Dorado (Ark.) Daily News* published an article which began, "The fact that employes at the American Oil Company refinery here are five times safer at work than off the job does not, so to speak, happen by accident."

This was the newspaper's way of announcing that Amoco's El Dorado refinery had reached another million man-hours of work without a lost-time injury; just a few days later it had also completed a full year of safe operation.

The article explained El Dorado's safety program and quoted J. Corbin Fernald, the refinery's safety supervisor, that the only formula for such an accomplishment is a steady and continuous program that keeps its message uppermost in the minds of employes. We constantly stress the fact that "safety is a personal thing."

Safety Talks. Take, for example, the well established "tool box" ses-



THIS

GIVES YOU THE SAME VAPOR THRU-PUT AS THIS

. . . because it's a Computer-Designed Hendrick Column Internal

An electronic computer now assures you of maximum process performance from Hendrick Perforating Trays. That's because this computer takes your design figures and combines them with carefully developed Hendrick formulas. The result is a set of specifications that exactly match your design requirements.

The specifications actually give you greater efficiency and at lower initial cost. You get higher vapor thru-put, less entrainment. You get a wide range of stable operation. Maintenance is easier. Tower construction is simpler. *And*...you save in the diameter of columns required for a specified process capacity.

Available in all types of commercially rolled metals. Stainless steel or other corrosion-resistant metals are recommended for corrosive services. As a result, you can now cut replacement costs and production losses caused by downtime, changeovers or cleaning.

HENDRICK
MANUFACTURING COMPANY

Perforated Metal • Perforated Metal Screens • Wedge Slot and Hendrick Wedge Wire Screens • Architectural Grilles • Mitco Open Steel Flooring • Shur-Site Treads • Armorgrids • Hendrick Hydro-Dehazer • Distillation Column Internals

Hendrick engineers will be happy to work with you in preparing Perforated Trays for use in your process equipment. Just clip the coupon for full information.

Hendrick is licensed to manufacture ESSO "Jet-Trays," SOCONY "Uniflux," SHELL "Turbo-Grid" and STONE and WEBSTER "Ripple" Trays. Hendrick is also equipped to supply all types of trays to specifications.

Manufacturers of Catalyst Support-Perforated Screen Beds

Hendrick Manufacturing Company
36 Dundaff Street, Carbondale, Penn.
Gentlemen:

☐ **Please send FREE Bulletin CI-2**

☐ **Have representative call**

Title_____ Name_____

Company_____

Address_____

City_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

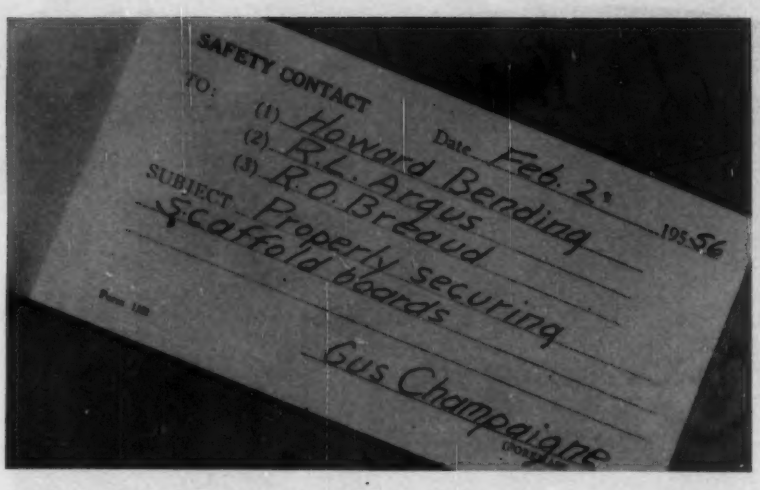


FIGURE 2—These safety "contact slips" are filled out by supervisors when they see an unsafe act. No names are used, but the information is incorporated into safety bulletins so that others are warned against following the same procedure.

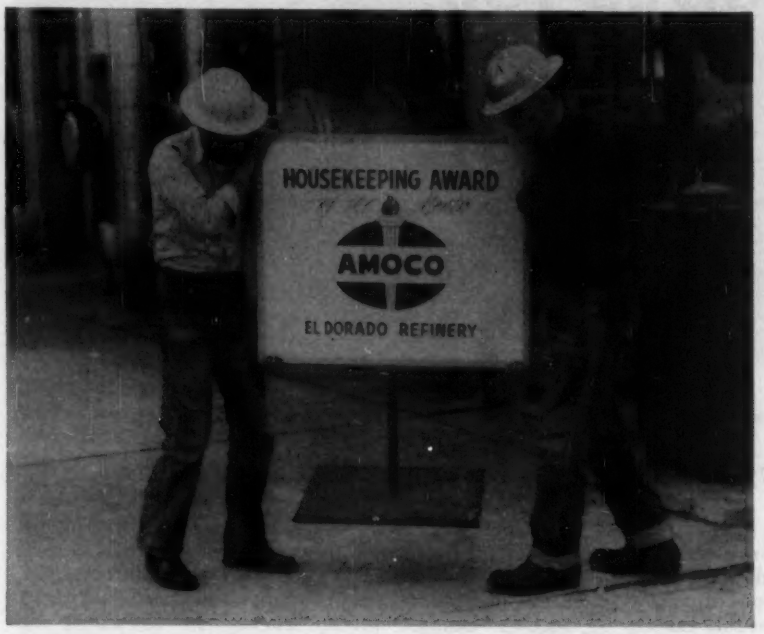


FIGURE 3—Part of the refinery's safety program includes a monthly "good housekeeping" award for the unit or department which shows the greatest improvement in neatness. This program, naturally, encourages people to think in terms of safety as it is linked to good housekeeping. The award includes a colorful sign which is displayed by the winning unit, as well as a gift of two pounds of coffee for each man on the unit's working crew.

sions at El Dorado. Once each week a supervisor gathers his men in the morning for a five-minute safety talk. As many as 50 are held each month throughout the plant. Sometimes, one of the hourly-paid employes will volunteer to conduct the short session, either talking on a general subject such as the wisdom of wearing safety glasses, or describing some unsafe act he personally saw on the job.

And if he did happen to see a fellow employe taking a risky short cut, the chances are good that it also was seen by one of El Dorado's 70 supervisors who discussed the possible danger with the man and then filled out a "contact slip." These slips, delivered to Safety Supervisor Fernald, mention no names. They merely describe the unsafe act so that others can be warned in safety bulletins against following the same practice.

Plant Gets Safer. El Dorado's safety history, until a few years ago, was uneven. In 1947 the refinery reached its first one million hours without a lost-time injury but began to slip back in 1951 and 1952 with year-end records of approximately 10 disabling injuries per million man hours. It was about this time that we launched the "personalized" program, now in effect.

The yearly results began to improve with accident frequencies falling first to 6.2, then 5.4 and 3.5. Then after a zero year in 1956, the big record of 774 days and 2,507,015 man hours without a disabling injury was reached in 1957. Again, on March 9, 1959, the million safe hour mark was passed on the run.

No Magic. When queried by other companies on the details of our safety program, we are quick to admit that we probably do nothing that is not already being followed elsewhere. There is no magic formula. But we do know our program is working. The company's big Texas City refinery also passed another million man-hours early this year. And in 1958, El Dorado refinery drivers covered 200,000 miles without a vehicular accident.

Accidents Were Up. To get the full picture of the development of Amoco's personalized safety program at El Dorado we must turn back to the early 1950's when accidental injuries were on the increase. The idea was prevalent among supervisors and employes that job or equipment hazards were the causes of accidents and were the reasons for mounting frequency rates.

Actually, the safety department was not too concerned about the "hazard" idea. We were sure that faulty equipment was not causing our injuries, but others had to be convinced. We had enough data to show what was causing the injuries —the answer was in the "Foreman's Report of Accidents."

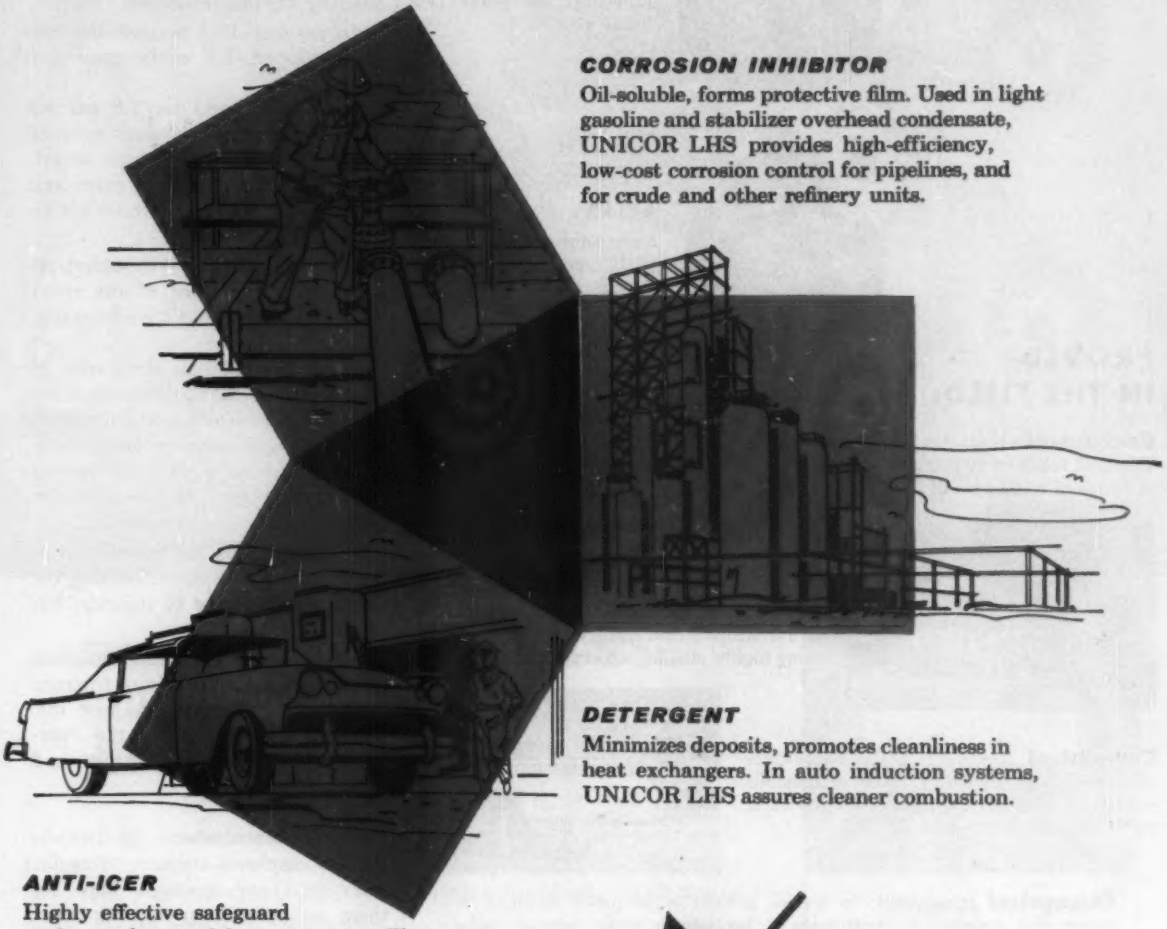
Supervisors are required to submit these reports on any injury which requires medical attention. We had 562 such reports available from a two-year period at El Dorado and another company refinery of the same size using similar equipment.

Human Failure. On each report, the foreman is asked to check the

New.... triple-purpose anti-icer

UNICOR LHS®

provides valuable refinery and pipeline service, too!



CORROSION INHIBITOR

Oil-soluble, forms protective film. Used in light gasoline and stabilizer overhead condensate, UNICOR LHS provides high-efficiency, low-cost corrosion control for pipelines, and for crude and other refinery units.

DETERGENT

Minimizes deposits, promotes cleanliness in heat exchangers. In auto induction systems, UNICOR LHS assures cleaner combustion.

ANTI-ICER

Highly effective safeguard against carburetor icing, prevents stalling. UNICOR LHS is convenient and economical to use, and is instantly miscible in lightest components of winter-grade gasolines.

Get the facts today! Write or phone for information and samples. Address our Products Department.

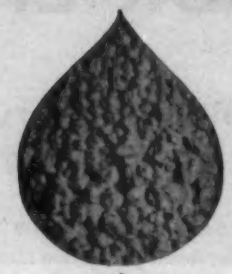
UOP

UNIVERSAL OIL PRODUCTS COMPANY

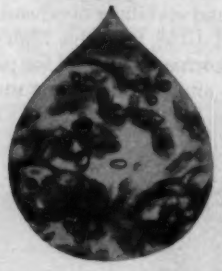
30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U.S.A.

CONCENTROL
PROVIDES
LOW COST, EFFECTIVE CONTROL of FOAM and BOILER WATER CARRY-OVER

PROVED IN THE LAB:



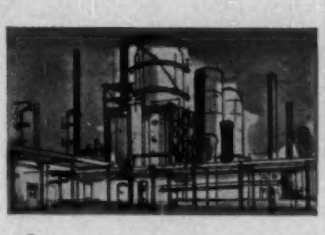
BEFORE: Foaming of highly alkaline solutions in glass test cylinder.

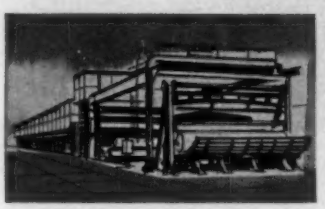


AFTER: Same solution after addition of 12 ppm of Bird-Archer Concentrol antifoam.

PROVED IN THE FIELD:

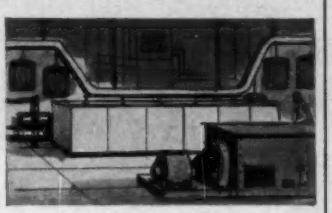
Concentrol eliminates foaming, maintains dissolved solids of 10,000 ppm with alkalinity in excess of 2,000 ppm in East Texas refinery.





Concentrol reduces blowdown rate from 15% to 5%, keeps steam quality high in paper mill using highly alkaline makeup water.

Concentrol eliminates boiler carry-over caused by high alkalinity for an automobile radiator manufacturer using a carbonate water that is Zeolite softened.



Concentrol is available in liquid, powder or briquette forms. Fast acting and resistant to hydrolysis or breakdown under normal boiler temperatures and pressures, it can be fed either continuously or in slugs to boilers. Many plants get the advantages of positive foam control *plus* boiler water sludge conditioning by using Concentrol in combination with organic sludge conditioning agents.

Let a Bird-Archer Water Treatment Engineer prove what Concentrol can do in your plant. Bird-Archer is always as near as your phone.

BA-602

BIRD-ARCHER
WATER TREATING CONSULTANTS
The BIRD-ARCHER Company, 4337 N. American St., Phila. 40, Pa.
New York, Chicago
The BIRD-ARCHER CO. of California, 415 Brannan St., San Francisco • Offices in Canada and Mexico

item which in his opinion was the real cause of the accident. We discovered that 31.3 percent of the injuries, almost one out of three, were caused by the individual's awkward or careless handling of tools or materials. He mashed his hand or finger, bumped his toe, cut or punctured his skin, hit himself, dropped an object on his foot or ankle.

Eye injuries accounted for 13.7 percent—some object or substance connected with the man's own work got into his eyes because he was not wearing his eye protection.

In another 13.7 percent the employe slipped, fell or bumped into some object.

Burns accounted for 7.8 percent of the injuries. The man grasped some hot object, a hot pipe or cylinder head, or opened a valve and splashed hot oil or hot water on his body.

Strained backs or shoulders resulted in 6.9 percent of the cases, which certainly could have been prevented.

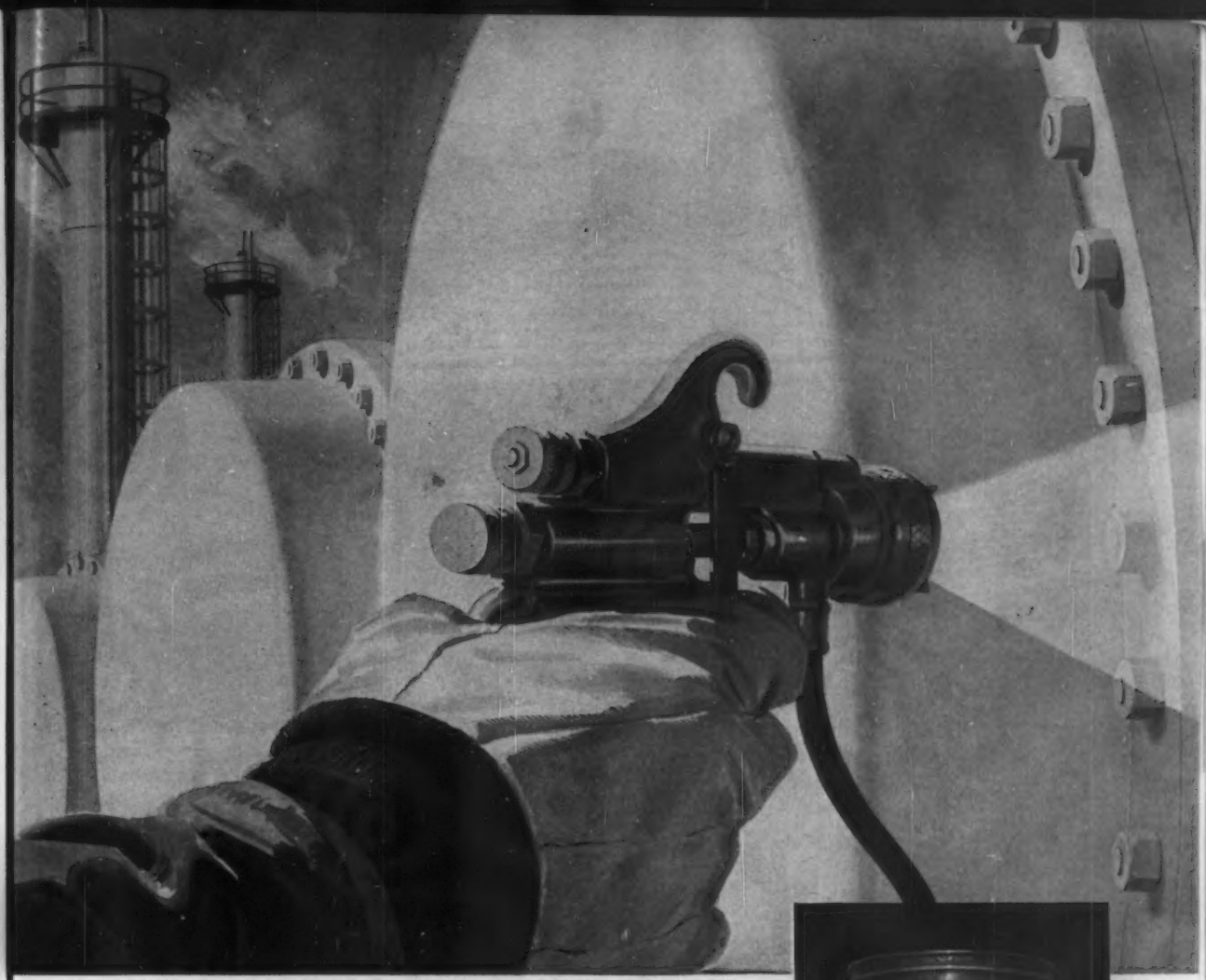
In the final analysis, there were 24 injuries which definitely were caused by insecure or leaking or improperly prepared equipment or scaffolding. They amounted to only 4.3 percent of all the injuries sent to a doctor, as reported by the foremen.

There we had the proof that it wasn't faulty equipment causing the major percentage of injuries, but people.

When these facts were explained to management, supervisors, foremen and the employes, it was not difficult to get support for the "personalized" safety program we had developed.

Constant Reminders. El Dorado refinery employes are never very far from a safety message. They see them on bulletins posted wherever the most people are likely to rest their eyes during a working day. As an example, as employes enter the refinery cafeteria they see several safety posters, such as, "There are 12 companies in the United States making glass eyes—Why?"

There are also the periodic bulletins circulated around the refinery, titled "Don't Let This Happen To You" or "Accident of the Month." It is a company-wide message describing an accident or near-accident that could have been avoided. These



Humble Coatings Give You Three-Way Reduction in Maintenance Costs!

Humble coatings last six months to a year longer than most other paints. You save *two* ways — on paint and labor. The *third,* and most important, way you save is this: you get better protection, which means longer life for expensive equipment.

Humble coatings contain rust-preventing ingredients that not only provide surface protection, but also neutralize any corrosive elements that may penetrate the surface protection and attack the metal. These coatings were specially developed to give maximum protection in refineries and chemical plants where strong acids, alkalis and salt sprays produce severe corrosive conditions.

Without cost or obligation, one of Humble's trained engineers will make a thorough study of your needs and recommend a complete painting program for you. Call your nearest Humble representative, or phone or write:

HUMBLE OIL & REFINING COMPANY
Consumer Sales, P.O. Box 2180,
Houston 1, Texas

Humble's line of coatings includes —

- RUST-BAN ®
- Vinyls
- Epoxies
- Acrylics
- Phenolics
- Enamels
- Tank coatings
- Hot surface coatings
- Interior and exterior emulsion-type paints

HUMBLE

Anyone can make a heat exchanger

It must be easy because there are currently 200 companies in the business. Many of these companies are primarily metal fabricators. Their products are fine for some industries. Other companies, Griscom-Russell for example, are specialists in the theory and engineering of heat exchange equipment. For over 90 engineering and research oriented years, Griscom-Russell has been designing and manufacturing a wide range of exceptional and economical heat exchange equipment. Many of our innovations are now standards. This reputation for *knowing our business* has brought us many of our customers . . . and helped us keep them. Would you care to test us?

Specialists in the engineering and construction of heat exchange equipment

air, gas and liquid heat exchangers, coolers and heaters—finned and bare tube, evaporators, steam generators, condensers, tank heaters, air-cooled fin-fan exchangers, sea water distilling plants, helically and longitudinally finned tubing, and many other products.

Griscom-Russell

A GENERAL PRECISION COMPANY

THE GRISCOM-RUSSELL COMPANY
MASSILLON, OHIO
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

GR-398

For more data on advertised products, use Readers' Service Cards, last page.

are worded so as to have news value for the widely distributed locations of the company's operations.

At first, only injuries from another Amoco refinery were used in these bulletins. But we soon found that employes do not object to being used as a subject at their own location because they realize that it promotes safety. We are convinced that these bulletins are much more effective than any other type of poster.

Inspection Teams. Another significant safety activity at El Dorado is the monthly inspection of the plant by two groups of four men each—one composed of foremen, and the other of maintenance employes. The groups get one new man each month, with the senior man dropping off after serving as chairman. Everybody gets a chance to serve sooner or later.

These safety inspections point to the fact that even though the company follows the "personalized" safety approach, the constant search for corrective action is highly important.

El Dorado's groups conduct separate inspections and make recommendations to the supervisory safety committee. The inspecting teams then are notified of the corrective actions taken. Because of this spirit of teamwork, everyone is more safety conscious.

Rewards. No company should overlook the opportunity to encourage the pride and fun associated with building up a good safety record. At El Dorado we do this by recognizing employes each time they pass 30 days without a lost-time injury. At these 30-day intervals, everybody gets a cigar or a bar of candy, depending on their choice. The gift is wrapped with a safety message, such as "Congratulations—*don't* take a chance, and win a cigar."

After working safely for 90 days, employes gather for a short safety rally. They hear a congratulatory talk by the refinery manager, then the safety supervisor holds a drawing for door prizes. Usually these prizes are six pairs of safety shoes and six electrical appliances, such as ice cream freezers or toasters.

Another point is that all new employes receive heavy safety indoctrination so they fit smoothly into the refinery's existing safety education

STAINLESS STEEL	FORGED and BAR MATERIAL CAST	ASTM-A-182 Grade F304, F316, F347, F304L ASTM-A-351 Cast analysis comparable to wrought grades.	150 Lb. Class
	FORGED and BAR MATERIAL	ASTM-A-182 Grade F304, F316, F347 and ELC material.	2000 Lb., 3000 Lb., 6000 Lb. Class
FORGED STEEL	FORGED and BAR MATERIAL	ASTM-A-105 Grade 2, Carbon Steel.	2000 Lb., 3000 Lb., 6000 Lb. Class
FORGED ALLOY STEEL	FORGED and BAR MATERIAL	ASTM-A-182 Grade F22, F5A, F-11	2000 Lb., 3000 Lb., 6000 Lb. Class

CAMCO
Quality
FITTINGS

Special non-standard fittings furnished to order

PR

CAMCO FITTINGS, INC.
North Haven, Connecticut

☐ Catalog covering complete line.
☐ Furnish address of area distributor.

Name .....
Company .....
Address .....
City ..... State .....

THE *Quality* LINE IN FITTINGS

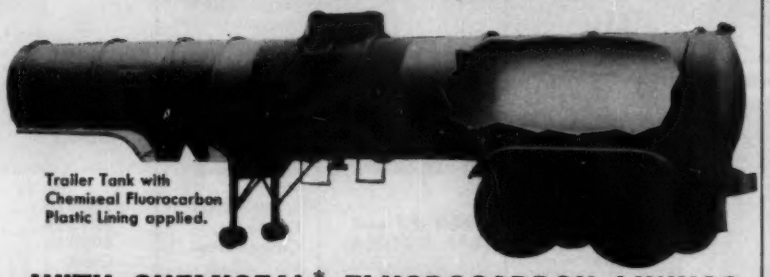
CAMCO FITTINGS, INC. North Haven, Conn.

For more data on advertised products, use Readers' Service Cards, last page.

Here's a real cost-saving idea!

CORROSION-PROOF

YOUR PRESENT EQUIPMENT . . .



Trailer Tank with Chemiseal Fluorocarbon Plastic Lining applied.

WITH CHEMISEAL* FLUOROCARBON LININGS

Instead of buying new equipment for corrosive service, simply have Chemiseal FLUOROCARBON PLASTIC LININGS applied to existing equipment. It's your assurance of positive chemical resistance without the high cost of special alloys, cladding, fused or baked linings!

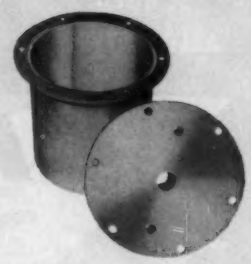
Hydrochloric, hydrofluoric, and nitric acids, plus the stronger alkalies, oxidants, and solvents, cannot harm Chemiseal FLUOROCARBON PLASTIC LININGS. They're easy to clean, non-brittle, non-contaminating, non-flammable, and can be used in temperatures ranging from −320°F to +250°F.

Most contours and materials (glass, wood, metal, concrete) can be covered easily and efficiently with Chemiseal FLUOROCARBON PLASTIC LININGS. Contact the skilled, factory-trained applicator nearest you for details on your application:

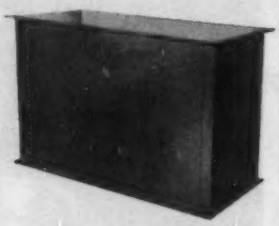
THE BARBER-WEBB COMPANY, INC., Los Angeles, Cal.
BELKE MFG. CO., INC., Chicago, Illinois
BUCKLEY IRON WORKS, Dorchester, Mass.
ELECTRO-CHEMICAL ENGRG. & MFG. CO., Emmaus, Pa.
LINCO, INC., Houston, Texas
METALWELD, INC., Philadelphia, Pa.

Or, write for Bulletin AD-152, Special Products Dept., United States Gasket Company, Camden 1, New Jersey.

*Registered trademark



Reactor Pot lined with Chemiseal Fluorocarbon Plastic.



Fluoride Tank lined with Chemiseal Fluorocarbon Plastic.

Pipe Coupling with Chemiseal Fluorocarbon Plastic Lining.

United States Gasket *Plastics Division of* GARLOCK

About the Author

J. B. Hamblen is safety director for American Oil Co., New York, where he is in charge of accident prevention for the entire company. He has a B.S. degree in chemical engineering from the University of Wisconsin and an M.S. degree in chemical engineering from MIT. Hamblen has been a plant and construction superintendent for U. S. Gypsum Co., chemical researcher for Standard Oil Co. (Ind.), assistant refinery superintendent, and general manager of manufacturing and safety director for Pan-Am Southern Corp. He has served on several API committees and is a member of the National Membership committee, American Society of Safety Engineers. A past board member of Metropolitan New Orleans Safety Council, he has also been chairman, American Society of Safety Engineers, New Orleans chapter.

program. Also all maintenance employes attend a combined safety talk every Monday morning, which, because of local atmosphere, are begun with a prayer.

Individual Action. It is heartening to see the response that we receive from employes. In plant newspapers, talented employes draw safety cartoons, making up their own messages. It is not unusual for a foreman to suddenly see a sign appear in his area reading, "Thursday's the day." It was made by an employe, without asking anyone, and it means that Thursday's the day the plant reaches another 90-day record.

At the company's new Yorktown, Va., refinery, a huge safety board at the entrance carries a new safety message each week, most of them submitted by employes. An example: "Safety is our premium product."

Keep this point in mind with regard to your plant's safety program, "If a man thinks 'safety'—he's going to work safely." ##

Will you reap the long-term payoff
of good mixer shaft sealing?

If you want to minimize your mechanical fluid mixing costs, take a hard look at *mixer shaft sealing.*

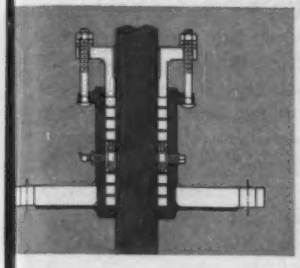
This is the area where profits can leak away unnoticed. The right shaft seal makes all the difference between an efficient mixing operation and a ruinously expensive one.

When you're aiming for low-cost shaft sealing, *don't be fooled* by low first cost. Instead, look for solid long-range savings you can make in terms of *smooth operation, rapid maintenance, minimum downtime.*

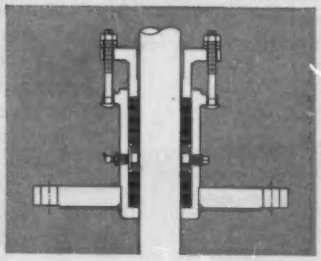
Here are some mechanical reasons why you get these savings with LIGHTNIN Mixers. Every one of the features illustrated below is a LIGHTNIN "first." Many are yours only with LIGHTNINs. And only LIGHTNINs give you *all* of them!

For lowest-cost fluid mixing, see your LIGHTNIN Mixer representative soon. Look him up in Refinery Catalog. Or write us direct.

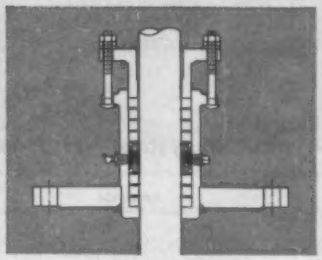
How you cut mixing cost with the *Lightnin* stuffing box



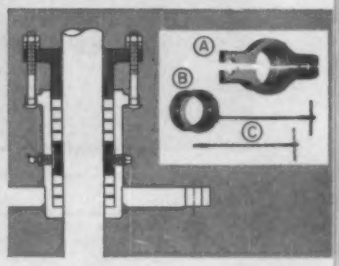
1. SAVE COST of a special-alloy mounting flange with all-welded LIGHTNIN construction. Forged steel flange is faced with correct alloy for your process conditions. Hub is solid alloy. Alloy parts are shown in gray.



2. GET SUPERIOR SEALING with 7 rings of large-cross-section packing. Separators facilitate packing removal, distribute force uniformly. Gland bolts, threaded part way, prevent overtightening.



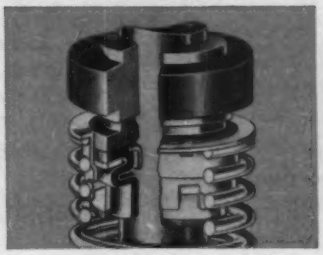
3. GET BETTER LUBRICATION without repacking. Lantern ring evenly distributes lubricant; permits continuous lubrication under pressure; extends time between repackings. Relief plug prevents overlubrication.



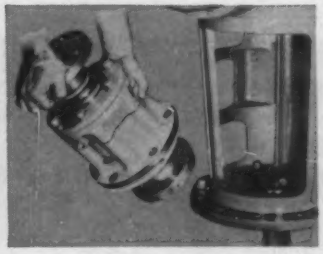
4. REPACK FASTER with exclusive split packing gland (A) that comes right off the shaft to allow maximum work space. Lantern ring (B) lifts out quickly by means of pullers (C), standard accessories.

Get simplest possible maintenance with *Lightnin* mechanical seal*

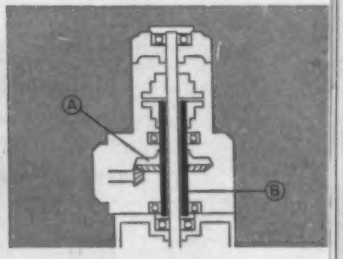
1. ELIMINATE REPACKING and adjustment with this cartridge-type LIGHTNIN rotary mechanical seal assembly, optional on all LIGHTNIN Mixers. It's saving many users thousands of maintenance dollars a year.



2. GET WIDEST CHOICE of seal designs and materials to meet your conditions: stainless steels, Stellite, Hastelloy alloys, bronze, ceramic, Teflon, etc. Handle pressures to 2500 psig and all temperature ranges.



3. REPLACE SEAL ASSEMBLY quickly, if ever necessary—without dismantling mixer or removing it from tank, and *without skilled manpower.* Seal cartridge unbolts, comes out as a unit; replacement bolts in.



4. RETAIN GEAR ALIGNMENT when changing seal. Mixer gears (A) are isolated from shaft by hollow drive quill† (B) —*cannot get out of line* when seal is removed. Shaft realignment is automatic on reassembly.

†patented

WHAT MIXING OPERATIONS are important to you? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ½ to 3 HP (B-108)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 164-g Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

Lightnin® Mixers

MIXCO fluid mixing specialists

*patent pending

New Acrylo Process for Ohio Standard

Everyone's talking about the new Standard Oil Co. (Ohio) acrylonitrile process, which is based on a single-step direct conversion of refinery propylene and anhydrous ammonia. Utilizing inexpensive raw materials readily available in ample quantity, the new route to acrylonitrile was developed in Sohio's Research Center, Cleveland, and is attracting international attention.

The process is a catalytic vapor phase one-step reaction operating at moderate temperatures (below 500° C), low pressure (less than 3 atms.), and residence times of a few seconds. It is highly selective, giving good yields of acrylonitrile and commercially recoverable amounts of acetonitrile and hydrogen cyanide.

Raw Materials. Refinery propylene streams and fertilizer-grade anhydrous ammonia are the only significant raw materials. Propylene concentration is not critical (40-90 percent being acceptable) and large amounts of low-molecular-weight hydrocarbons can be tolerated in the feed stream. In some cases, economics may warrant a preconcentration of the propylene, but this is not a requirement of the process.

Pilot Unit. Although completely new, the process has been tested extensively in a one-ton-per-month pilot unit at Sohio's Cleveland Research Center.

Product Quality. The product obtained is very pure and completely free from troublesome impurities (methyl vinyl ketone, divinyl acetylene, and cyanobutadiene). It is fiber grade and meets major domestic consumer's specification trials. Pilot plant quantities have been polymerized, spun, dyed, and aged without difficulty.

Catalyst Aspects. The catalyst is used as a fluidized bed. It is durable chemically, physically, and thermally, and depends for its activity on a high concentration of active ingredients rather than a trace constituent. Thus, it is not readily affected with trace contaminants. However, desulfurized hydrocarbon feed should be used to prevent bulk sulfate lay-down. The catalyst has been prepared in large amounts in commercial size equipment.

Commercial Plant Aspects. The first commercial plant to use the new process is being built at Lima, Ohio, and will go on stream early in 1960. To be operated by Sohio Chemical

Acrylonitrile—Typical Analysis of Pilot Plant Product

Item No.		Analysis	Specifications
1	Acetone	50 ppm	300 max.
2	Acetonitrile	350 ppm	500 max.
3	Acrolein	10 ppm	5 max.
4	Acidity	15 ppm	20 max.
5	Aldehydes	15 ppm	50 max.
6	Copper	0.02 ppm	0.10 max.
7	HCN	2 ppm	5 ppm max.
8	Iron	0.05 ppm	0.10 max.
9	Water	0.35%/Wt.	0.25-0.45
10	Cyanobutadiene	None	None
11	Divinyl Acetylene	None	None
12	Methyl Vinyl Ketone	None	None
13	Peroxides	None	0.2 ppm max.
14	Appearance	Clear	Clear
15	Color, APHA	less than 5	5 max.
16	Distillation Range	75.0°C. to 77.2°C.	74.5°C to 78.5°C
17	Inhibitor	45 ppm	35-45
18	Non-Vol. Matter	10 ppm	100 max.
19	Oxygen Bomb Stability	greater than 4 hrs.	4 hrs.
20	pH	6.6	6.0-9.0
21	Refractive Index n_D	1.3888	1.3882-1.3891
22	Titration Value	0.5 ml.	0-2
23	Specific Gravity 25°/15.5°C.	0.7996	0.7990-0.8020

The acetonitrile will be of similar high quality as indicated in the following tentative specifications:

Tentative Sohio Acetonitrile Product Specifications

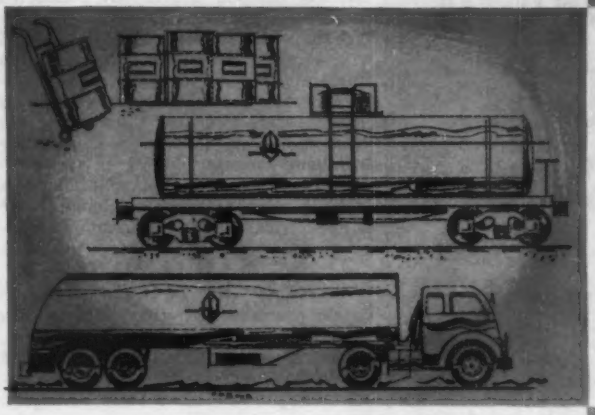
	Minimum	Maximum
Specific Gravity at 20°/20°C.	0.782	0.785
Distillation, 760 mm Hg	Ibp 80°C.	DP 82°C.
Acetonitrile, %/Wt.	99.0	.....
Acidity, Max. as Acetic Acid, %/Wt.	.....	0.08
Acetone	None by Test	
Free Ammonia	None by Test	
Water, %/Wt.	.....	0.03
Color, APHA Pt-Co	.....	5
Suspended Matter	Substantially free	
Acrylonitrile, and other Polymerizable Monomers, %/Wt.	.....	0.05
HCN, ppm	.....	5
Other Saturated Nitrated, %/Wt.	.....	0.05

Flowing Pressure	Flowing Temperature	Temp. Correction Factor, F_t	Press. Correction Factor, F_p	Combined Factor, F_{tp}
35 psig	40°F	1.0189	0.9531	0.9720
35 psig	60°F	1.0000	0.9531	0.9531
35 psig	80°F	0.9813	0.9531	0.9353

Gas Processors get all three from Jefferson!

1 THE RIGHT CHEMICALS . . .

for efficient Natural Gas Sweetening, Refinery Stream Sweetening, Sulfur Recovery, Solvent Extraction, Carbon Dioxide Absorption, Gas Dehydration, and Hydrate Prevention.

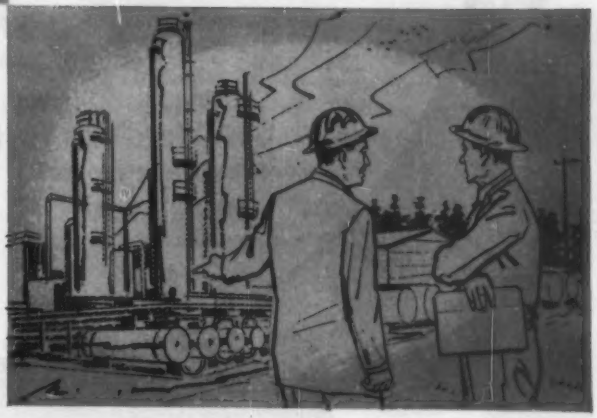


2 ON-SCHEDULE DELIVERIES . . .

when and where and in any quantities you require . . . 55-gal. drums, 1-4,000-gal. tank wagons, 4-10,000-gal. tank cars . . . single product or combination shipments.

3 HELPFUL TECHNICAL SERVICES . . .

like those relating to proper storage and handling, or complete analyses of your gas-scrubbing agents, or just any way the Jefferson people can help you lick a problem. Your request to 1121 Walker Avenue, Houston 2, Texas, will bring helpful answers on the double.



Ethylene Oxide, Glycols, Dichloride • Ethanolamines • Morpholine • Piperazine
Polyethylene Glycols • Nonyl Phenol • SURFONIC® Surface-Active Agents
Ethylene Carbonate and Propylene Carbonate • Caustic Potash • Caustic Soda
Soda Ash • Sodium Bicarbonate

Essential Chemicals From Hydrocarbon Sources

JEFFERSON CHEMICAL COMPANY, INC.

HOUSTON • NEW YORK • CHICAGO • CLEVELAND
CHARLOTTE • LOS ANGELES

147

For more data on advertised products, use Readers' Service Cards, last page.

Co., it will have a low electrical load, a relatively small water requirement, will be self-sufficient in its steam requirements and will produce no unusual water effluent. So, site selection can be based entirely on raw material availability and product transportation aspects.

Chemistry of the Process. The process chemistry is represented by the following equation:

$$CH_2=CH-CH_3+NH_3+\frac{3}{2}O_2 \xrightarrow[(Air)]{CAT.} CH_2=CH-CN+3H_2O$$

Minor amounts of acetonitrile and hydrogen cyanide are also obtained. These may originate by oxidative attack on the propylene molecule at the double bond rather than at the methyl group.

Selectivity of the reaction is primarily due to the catalysts' nature and process conditions. Many catalysts will give trace quantities of acrylonitrile from this reaction, but it has taken much research to produce high activity and selectivity with the Sohio acrylonitrile catalysts.

Approximately stoichiometric quantities of oxygen and ammonia are used. As for reaction requirements—it is unimportant whether oxygen or air is employed. Air is, of course, less costly and diluent nitrogen does not enlarge the reactor enough to warrant a separate oxygen plant.

CO and CO_2 are both produced in large amounts and are the major nonproductive propylene consumption. Propane and lower hydrocarbons, including ethylene, are inert under the reaction conditions. Butylene and higher hydrocarbons do tend to react under process conditions, giving complex product mixtures. Therefore, they should be avoided in the feed streams, although trace quantities might be tolerated.

This direct process chemistry can be contrasted with other routes to acrylonitrile, using propylene as a major raw material. These would include intial oxidation of propylene to acrolein—then processing to derive acrylonitrile oxidatively from acrolein and ammonia.

Other prior processes require more costly raw materials, notably hydrogen cyanide and ethylene oxide or acetylene. The original synthesis was from ethylene cyanohydrin in 1893, and this is still one of the commercial routes. Reaction of acetylene and hydrogen cyanide at elevated temperatures was disclosed in 1930, but this reaction is generally conducted in aqueous catalyst solutions in commercial practice today. Because of the need to generate acetylene for this process, an attempt was made to react readily available unsaturated hydrocarbons (such as ethylene and propylene) with hydrogen cyanide. To avoid the need of handling hydrogen cyanide, it was proposed to react propylene with ammonia, but yields by this reaction were not competitive with acetylene processes commercially established by that time.

Product Recovery. Hydrocarbon oxidation processes are often plagued with very complex product recovery systems. Because of the simple mixture obtained in the Sohio acrylonitrile process, recovery and purification steps are quite simple.

Reactor effluent is treated to separate fixed gases and unreacted hydrocarbons. These pass to a stack or to hydrocarbon recovery equipment as the particular hydrocarbon feed compositions and values dictate. Acrylonitrile is finished by means of drying and final distillation step.

By-product acetonitrile is converted to high-purity product by drying and a final distillation. A high concentration HCN stream can also be available for commercial processing if desired.

In cooperation with Badger Manufacturing Co., these product recovery steps have all been extensively checked in continuous laboratory equipment made up of Oldershaw column units of one and two-inch diameter, and appropriate platage. The Oldershaw construction resembles a minature glass sieve tray design, complete with downcomers. Correlations of work done in this type of equipment with industrial-scale operation has generally been excellent.

Product Quality. The quality of product produced in larger pilot-scale equipment, also of the Oldershaw type, has been unusually high. It is typified by the

TRIANGLE BRAND
COPPER SULFATE
the Superior Reagent for "Sweetening"
Sweetening in oil refining and processing demands a superior reagent either in the dry form or in aqueous solutions. Triangle Brand Copper Sulfate is versatile and is effective in partly desulphurizing oil, or removing mercaptans, other sulphur compounds, malodorous and resinous substances from cracked distillates.
Triangle Brand Copper Sulfate, 99% pure, will be your reagent of choice once you use it!
PHELPS DODGE REFINING CORPORATION
NICHOLS
TRIANGLE BRAND
REG U.S. PAT OFF.
CHEMICALS
NEW YORK N.Y.
PHELPS DODGE REFINING CORPORATION
300 Park Avenue, New York 22, N. Y.

the BIG show is always INSIDE

You can't judge the show by listening to the barker's slick chatter outside the tent — the big show itself is always inside. The same thing holds true for forged steel utility valves. From the outside they look very much alike — it's what's inside that really matters.

Built into all SMITH Forged Steel Valves is a combination of special features suggested by leading engineers of the Refinery, Chemical and Petrochemical industries — the men best qualified to know the solution to the valve problems of their respective industries. These features give SMITH Valves extra stamina to meet the challenge of ever-increasing temperatures, pressures and corrosion — give you longer trouble-free life in service with lowest maintenance cost.

Write today for our catalog giving full details on the complete SMITH Valve line — gates, globes and needle globes — screwed, socket weld and flanged ends.

NEW ENGLAND VALVE Corporation

BOX 1047 • WORCESTER, MASSACHUSETTS

NEW ENGLAND VALVE CORP. OF CANADA, LTD.
FACTORY AND OFFICES
1 SENECA AVENUE • PORT CREDIT, ONTARIO

For more data on advertised products, use Readers' Service Cards, last page.

series of analyses and tentative specifications shown in the table.

Economics and Manufacturing Considerations. Economic studies made in conjunction with Badger, U.S.A., and Badger, N.V., show that for nearly all foreseeable economic conditions and plant sizes, the Sohio process compares favorably with conventional routes in respect to investment, raw materials, operating costs, and product quality.

Small plants can be competitive with larger ones which had to be integrated with hydrogen cyanide and acetylene or ethylene oxide production. Plants need not be at the raw material site, since both propylene and anhydrous ammonia are readily transported. Plant construction materials are conventional and all operations are at little greater than atmospheric pressure except for high pressure steam generation. Catalyst manufacturing technique is well worked out and could be done locally if desirable. Particle fabrication and calcination are the major process steps in catalyst production.

This new process will likely become an important factor in future world-wide production of acrylonitrile. This is because of the greater abundance of suitable raw material facilities, greater freedom of choice of economic plant sizes and locations, process simplicity, lack of necessity to feed and store hazardous HCN, and high product quality.

Helium Reports Available On Open-File Basis

Basic information on the characteristics of helium-bearing natural gas is given in two Bureau of Mines reports just placed on open file by the Department of the Interior. They present, in easy-to-use form, the results of Bureau studies on helium-bearing gas from the Cliffside Field, Amarillo, Texas, and the Keyes Field, Cimarron County, Oklahoma, and can be consulted during regular office hours at three locations.

Copies can be seen at the Bureau's Amarillo helium plant, in the office of the assistant director, Helium, Room 514, Barfield Building, Amarillo, and in the Bureau's Helium Liaison Office, Room 4627, Interior Building, Washington, D.C. The file is designated: "Open File of Information Relating to the Extraction of Helium from Natural gas by Low-Temperature Processes."

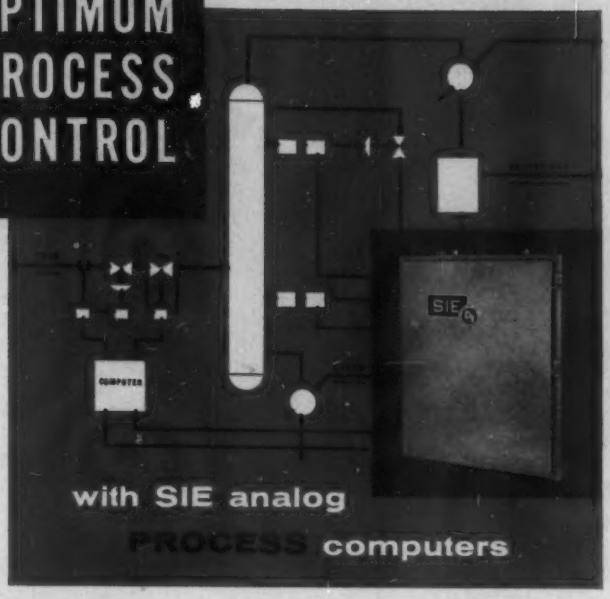
Analytical Methods Show Phosphorus in Gasoline

The phosphorus content of gasoline can be rapidly and accurately determined by either of two recently developed analytical methods, says W. R. O'Neill of Ethyl Corp.'s Research laboratories, Detroit. The growing use of phosphorus compounds as gasoline additives to combat preignition and spark-plug fouling has created a need for rapid methods of determining phosphorus in gasoline. To satisfy this need, two analytical procedures — one spectrographic and the other colorimetric — were developed in Ethyl's laboratories. The spectrographic method has a standard deviation of 0.8 milligrams per liter, and 35 determinations can be made per man-day. By comparison, the colorimetric method is somewhat more accurate with a standard deviation of 0.5 milligrams per liter, but somewhat slower, with 24 determinations per man-day. Neither method is affected by additives such as tetraethyl lead, antioxidants, or metal deactivators.

In the spectrograph method, the gasoline is analyzed in an emission spectrograph without pretreatment except for the addition of a radiation buffer and an internal standard to minimize variations in phosphorus line intensity. One analytical curve serves for samples containing commonly used phosphorus additives. However, separate curves are required for samples containing more volatile phosphorus compounds.

In the colorimetric method, the gasoline is adsorbed on zinc oxide and ig-

OPTIMUM PROCESS CONTROL



no ● moving parts
no ● vacuum tubes
no ● contacts

SIE CM-2 Analog Computers provide precise control in chemical, petrochemical, refining, and similar process applications, to a degree never before possible. Using this new concept, process variables are taken into account in adjusting set-points automatically to achieve optimum output yield.

Using Magnetic Amplifiers and Transistors CM-2 Series Computers have a **trouble-free life expectancy in excess of 100,000 hours,** yet in a typical fractionator application now in operation, computer cost was less than $5000.

Write for Brochure Describing Applications in Feed-Ahead, Feed-Back, and Operator Guidance computations. SIE engineers will welcome the opportunity to discuss the use of CM computers in your specialized process control applications.

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.
A Division of Dresser Industries, Inc.
10201 Westheimer • P. O. Box 13058 • Houston 19, Tex.

STEEL PLATE FABRICATION
For the Petroleum Industry

OUR experience in producing welded steel plate structures dates back to 1910. We have the experience. the know-how and the facilities to design and fabricate almost any type of structure required by the petroleum industry. Your request for information or estimates will receive careful attention.

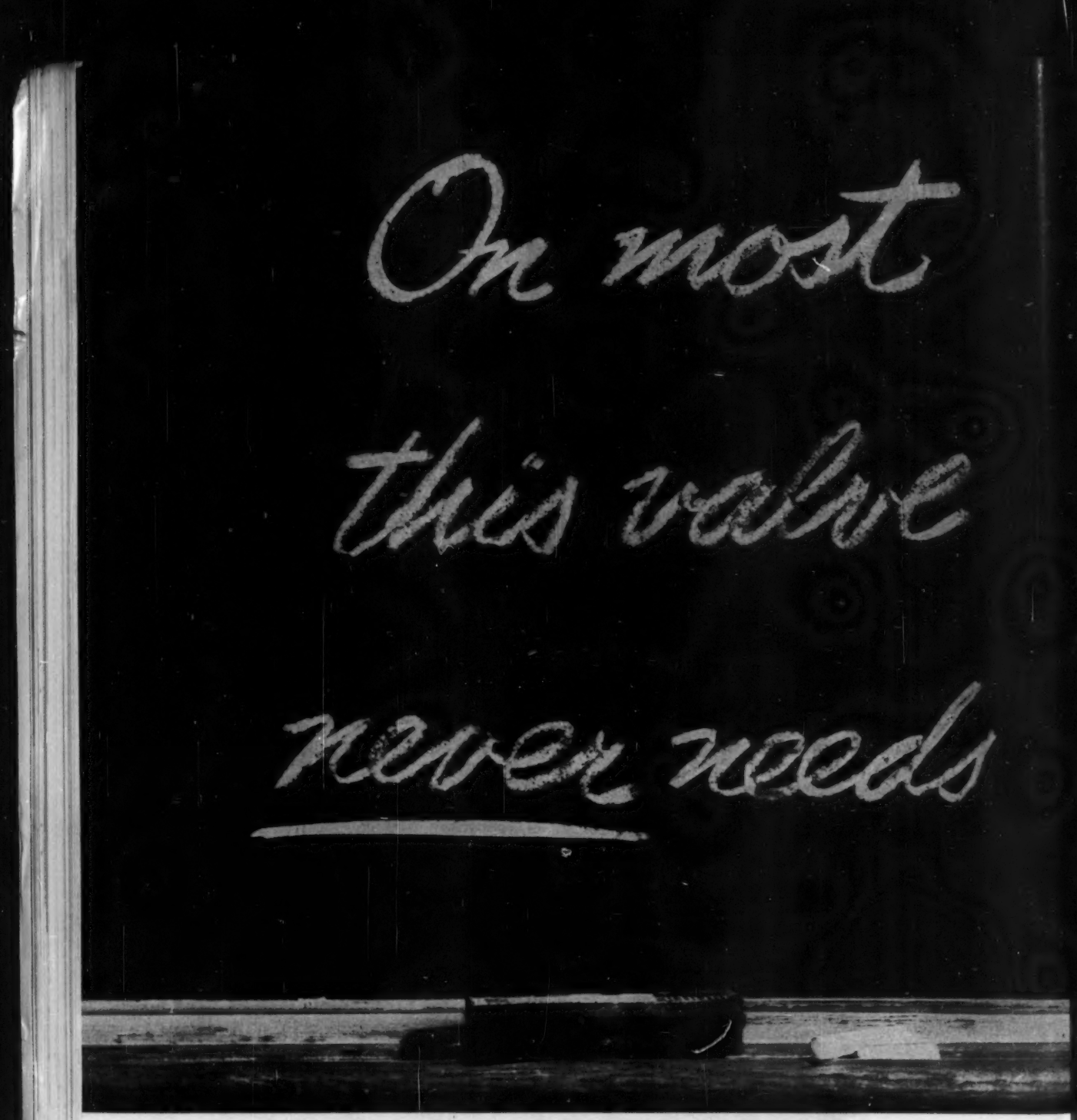
POSEY IRON WORKS, INC.
LANCASTER, PENNSYLVANIA
NEW YORK OFFICE: GRAYBAR BUILDING

RIGHT—TOWER
8′ Dia.—70′ High

BELOW—PRESSURE VESSEL
13′7″ Dia.—43′7″ Long

DIVISIONS: STEEL PLATE FABRICATION • GRAY IRON AND STEEL FOUNDRY • BRICK MACHINERY AND MIXERS • INDUSTRIAL HEATING • IROQUOIS ASPHALT PLANT • TUNNEL AND MINE EQUIPMENT

For more data on advertised products, use Readers' Service Cards, last page.



There are a few valve-killing services where Rockwell-Nordstrom valves *do* fail—after outlasting non-lubricated valves by ten or twenty times. But on *most* services—when properly specified and properly maintained—they last as long as the installation of which they're a part. This is why: Rockwell-Nordstrom valves are *lubricated*. Pressurized lubricant in the Sealdport system does three things. 1) It creates a powerful leak-proof seal that can't be permanently damaged because it *renews itself*. 2) By hydraulically cushioning the plug, lubricant *prevents freezing and jamming*. 3) Lubricant protects every moving part against wearing *friction* and no vital part is exposed to the line. The lubri-

Lubrication makes the

cation largely eliminates the *causes* of valve failure. How much would you save if you had a valve that never needed to be replaced—or that outlasted your present valves by ten or twenty times? Try just *one* Rockwell-Nordstrom Valve on your toughest service. *Rockwell Manufacturing Co., Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Ltd.*

ROCKWELL-Nordstrom VALVES

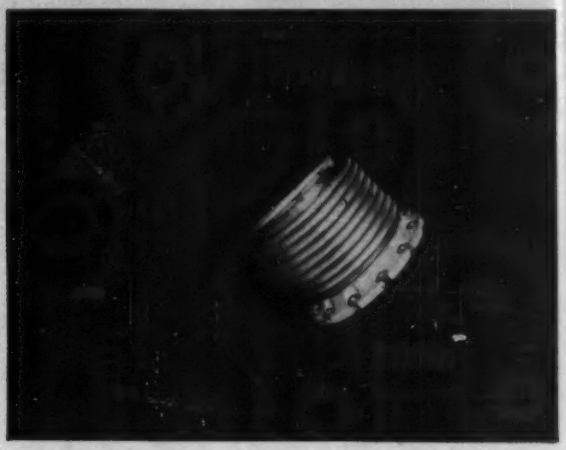
another fine product by

ROCKWELL

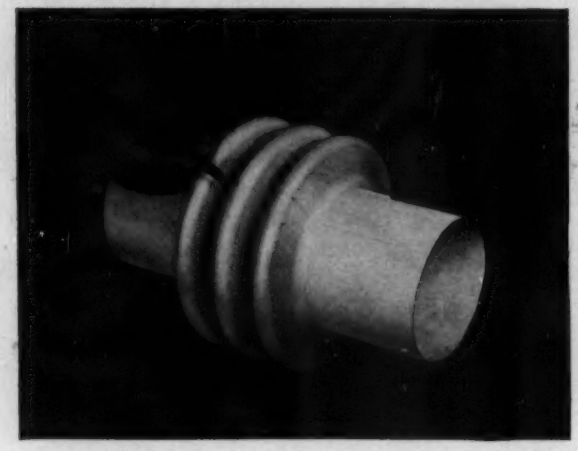
difference . . . . . .

4 WAYS to get maximum reliability in expansion joints

1 Insist that the corrugated bellows be hydraulically formed. The reason is simple. Whenever bellows are formed by circumferential welding . . . whether by edge, seam or fillet welding . . . they will always be subject to premature failure because of stress concentrations at the welds.



2 Be sure the manufacturer maintains a continuous and comprehensive program of endurance testing. This is basic, because of the many variables that affect expansion joint life. Accurate determination of expansion joint life expectancy can only be determined by cycling to destruction.



3 Demand proof that the manufacturer can produce longitudinal welds in the corrugated bellows having the same strength, physical properties and thickness as the parent metal . . . without grinding. A weld that is hard to find is a ground weld. Variations in weld thickness set up points of stress concentration . . . opening the way for premature failure.

4 Check the ability of the manufacturer to supply a team of *competent* design and application specialists to work with your engineers. Check their specific experience in handling critical, complex applications in your field . . . complete to the record of successes or failures behind them, and details of how this experience will be brought to bear on your problem.

At Zallea, none of the many factors affecting expansion joint reliability are left to guesswork . . . including the four vital ones above.

This is reflected in these facts. Zallea material specifications are the most exacting in the industry. Zallea expansion joints are hydraulically formed. Zallea advanced welding techniques insure welds having the same thickness, strength and physical properties as the parent metal. Zallea has done more cyclic testing to destruction than all government agencies and industrial firms combined. Zallea has produced more expansion joints than any other manufacturer . . . offers more application engineering experience.

For all the facts, write for Catalog 56. Zallea Brothers, Taylor and Locust Streets, Wilmington 99, Delaware.

Zallea for maximum reliability

ZALLEA BROTHERS, Wilmington 99, Delaware • World's largest manufacturer of expansion joints

nited. This converts the phosphorus to the orthophosphate ion, which is determined colorimetrically by a molybdenum blue method. Unlike the spectrographic method, the colorimetric method can be applied to samples containing unknown phosphorus additives.

July Crude Demand Forecast By U.S. Bureau of Mines

The Bureau of Mines forecasts July crude demand in four states as follows: Texas, 2,650,000 bpd, no change from June; Oklahoma, 565,000 bpd, up 5,000; Kansas, 340,000 bpd, up 5,000; and New Mexico, 295,000 bpd, no change.

Contract to Buy Soviet Benzene Comes Under Fire

A $13.5-million contract under which American interests will buy Soviet-produced benzene has been criticized from the Senate floor by Senator Schoeppel (R-Kan.), among others. He said, "it is surprising to me and many others in the domestic industry that leading firms in American business are purchasing Soviet-produced materials and products when there exists in this country, in some instances, an oversupply of the same product readily available for use." The senator said the benzene transaction "creates a favorable international trade position for the Soviet Union."

Schoeppel added that Senate Commerce Committee will soon begin its inquiry into foreign trade and "I am suggesting several topics within this area (Red trade with the West) which I consider to be worthy of committee study."

Auto, Truck Mileage Statistics Reported

In 1957 the average passenger car was driven 9,391 miles and consumed 652 gallons of gasoline at an average rate of 14.4 mpg, according to a recent report by the Bureau of Public Roads. The average truck or truck-trailer combination traveled 10 percent farther, or about 10,328 miles, and consumed twice as much fuel, 1,312 gallons, for a mileage rate of 7.87 per gallon. These figures came from a bureau report which forecasts continued increase in mileage driven. Figures for 1957, the latest year covered, showed a gross of 647-billion vehicle miles. The Bureau estimates that 1958 reports, when available, will show 665-billion miles driven. The report estimates the 1959 total at 700-billion vehicle miles.

LPG Production, Demand Reported for March, April

Daily average production of natural gas liquids in April was 37 million gallons, one percent less than March 1959, according to the Bureau of Mines. Daily average production of liquefied gases at refineries was eight million gallons.

Demand for LPG for fuel and chemical uses decreased eight percent during

Happenings . . .

April. Stocks of LPG totaled 717 million gallons, 236 million gallons above a year ago. Underground stocks of LPG titaled 510 million gallons, an increase of 135 million gallons, during April 1959. Daily average demand for natural gasoline in April was 10 million gallons, unchanged.

Daily average production of natural gas liquids in March was 37 million gallons, two percent less than February, 1959. Daily average production of liquefied gases at refineries increased three percent over February. Demand for LPG for fuel and chemical uses in March declined 16 percent. Stocks of LPG totaled 559 million gallons, 166 million gallons above year ago. Underground stocks of LPG at plants and terminals totaled 375 million gallons on March 31, an increase of 99 million gallons during March.

Building Materials Field To Boost Petrochemicals

Petrochemical production in 1958 reached 42 billion pounds or 28 percent of total chemical production—but the value of this production was $5.2 billion, or 57 percent of the value of total chemical production, according to Dr. Jerry McAfee, vice president of Gulf Oil Co. Still, he said, petrochemicals are a small segment of petroleum industry, requiring only about 150,000 bpd equivalent of hydrocarbons, or between one percent and two percent of total hydrocarbons output. McAfee said the field of building materials showed the greatest promise for petrochemicals applications, as part of trend toward replacing more and more natural products by synthetic products.

"The large amount of research work being done in the petrochemical field will insure that new and improved products will continually be evolved," McAfee added. He pointed to the increasingly international character of the petrochemicals industry and linked overseas development to the growing emergence of hydrocarbons as a raw materials source in areas formerly dependent on coal or wood.

Further Restraints on Fuel-Oil Use Proposed for L.A.

New proposals on the prohibition of fuel-oil use as a measure to combat smog have been made to the Los Angeles County Board of Supervisors by R. L. Minckler, acting chairman of Western Oil & Gas Association's Air Pollution Policy Committee. He suggested that Rule 62, the rule under which burning of fuel oil of more than 0.05 percent sulfur content is barred in the county from May to September, could be strengthened. He suggested:

- That the rule be applied all year.
- That fuels of more than 0.05 percent sulfur content couldn't be burned when sulfur dioxide levels reach one part per million at any two monitoring stations.
- That such fuels couldn't be burned at all when smog is forecast.

Aloyco Valves on 26-year duty in hot acid system

Still going strong in the sulphite pulp mill of Eastern Fine Paper and Pulp Division, Standard Packaging Corp., at South Brewer, Maine, is the Aloyco Stainless Steel "Y" valve, above.

This, and other Aloyco Valves were purchased in 1933 when the hot acid system was installed here. They have been in continuous use ever since.

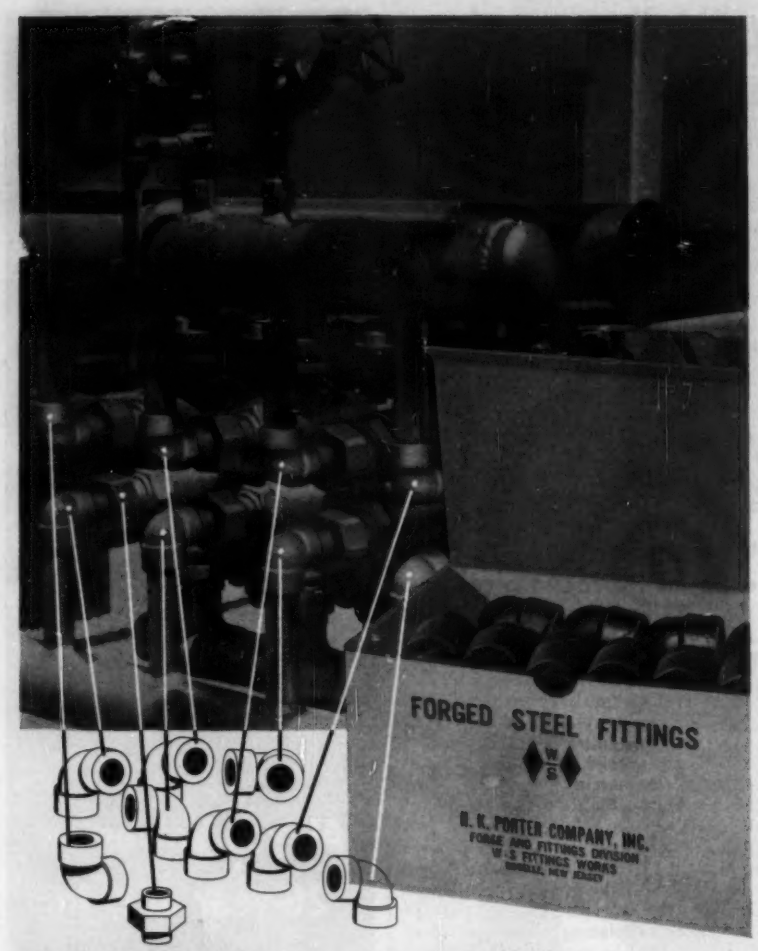
Long trouble free service is the reason so many U. S. plants are turning to stainless steel and high alloy valves . . . even for mild corrosive service.

Only one company has specialized in corrosion-resistant valves exclusively for 30 years: Alloy Steel Products Co. Call us in on your next valve job. Write us at 1303 West Elizabeth Ave. 9.7

Longer Lasting ALOYCO VALVES

ALLOY STEEL PRODUCTS COMPANY
Linden, New Jersey

For more data on advertised products, use Readers' Service Cards, last page.



FORGED for long life
PACKAGED for convenience

The "Forged" in W-S Forged Fittings means dependability under the toughest piping-job conditions. "Forged" gives you the added resistance to pressure, heat, corrosion, shock and vibration needed to make your installations long-lived and safe. And W-S Fittings are easily installed, with tight fits and perfect alignment . . . thanks to W-S precision machining methods and quality forging techniques.

Packaging, too, is a W-S brand advantage. Virtually any "mix" of fitting types and sizes can be packed in a convenient W-S Case or Half-case . . . each type and size in its own carton.

Specify W-S on your next order. For specifications and Distributor locations, write *Forge and Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, New Jersey.*

FORGE AND PORTER FITTINGS DIVISION

H.K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Copper and Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION; and in Canada, Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.

—Changing Times—

Derby Refining Co.'s name has been changed to Derby Refining Co. Division, Colorado Oil & Gas Corp. Derby has refinery at Wichita, Kan.

Armour Chemical Division, Armour & Co., has bought Mississippi Chemical Corp.'s 240-ton-a-day anhydrous ammonia plant near Festus, Mo. Plant also makes nitrogen solutions and ammonium nitrate. Armour previously got all its nitrogen fertilizers from other producers.

Texas Gas Corp. has been acquired by a group headed by Carl M. Loeb, Rhoades & Co., investment bankers of New York; Godfrey L. Cabot, Inc., Boston, and Russell M. Riggins, Houston, president of Texas Gas. **Company operates one of largest gas processing plants on the Gulf Coast at Winnie, Texas,** processing approximately 225 Mmcf. A companion oil refinery produces 10,000 bpd.

American Independent Oil Co. will move headquarters to 50 Rockefeller Plaza, New York, on August 1. Office of Ralph K. Davies, chairman, will remain in San Francisco.

Permanent Council of the **World Petroleum Congress has picked West Germany as the site of next meeting,** and elected Sir Stephen Gibson, C.B.E., Council Member, Institute of Petroleum, Great Britain, as next Chairman. No city or date was chosen.

Eastern States Petroleum and Chemical Co., Houston, and Signal Oil and Gas Co., Los Angeles, are completing final details for merger. Signal will get 60,000-bpd refinery and petrochemical plant on Houston ship channel—also marine terminal and interest in pipeline from West Texas to Houston.

Shell interests will buy into Koppartrans, refining and marketing firm in Sweden, outbidding two other international oil companies. Koppartrans has 33,000-bpd refinery in Goteborg.

E. I. duPont de Nemours & Co. has developed instrument for measuring presence and extent of surface ignition. Instrument makes it possible to conduct **surface ignition studies on any automobile by installing special pressure-sensing spark plugs,** thus simulating actual service conditions.

Texaco and Superior Oil Co., Los Angeles, have reached "understanding in principle" on merger under which Superior stockholders would get 24 shares of Texaco stock for each share of Superior. Texaco would assume Superior's liabilities —Superior would be dissolved. **Representatives of companies are working out details.**

API study on hydrocarbon composition of single barrel of crude—lasting 33 years and costing more than $1 million—**has succeeded only in identifying 169 hydrocarbons out of more than one million estimated to exist.**

Plans for acquisition by North American Aviation, Inc., of The Foster Wheeler Corp. have been discontinued. Companies decided "mutual benefits originally expected from merger would not be realized."

Pauley Petroleum Co. as acquired Newhall Refining Co., Newhall, Calif., for undisclosed price. Newhall has 2,400-bpd refinery that will be increased to 3,600 bpd by installation of fractionating tower.

Thousands going up the stack?

Reduce Flaring Losses
Control Air Pollution
with the "Anemotherm" Probe–Type Gas Flow Meter

You can stop profits from going up the flare stack with the new "Anemotherm" *Probe-Type* Gas Flow Meter. This *electronic, stainless steel* instrument quickly locates points of loss . . . accurately measures gas flow from 10 to 15,000 FPM with a scale range of 500 to 1. Refineries report savings of thousands of dollars per day.

The new "Anemotherm" Gas Flow Meter offers many exclusive features. Sixteen probe meters can be connected to one strip recorder so that flow in sixteen process lines can be observed and recorded by one instrument. The probe is self-compensating for ambient temperature and can be used in gas streams to 300°F. The probe has fast response, is corrosion resistant and streamlined. Accuracy is ± 5% of meter reading. The "Anemotherm" Gas Flow Meter is easy to install and easy to clean.

Look into the money-saving accuracy and efficiency of the "Anemotherm" Gas Flow Meter. For complete engineering data send for Technical Bulletin 5000.

ANEMOSTAT®

ANEMOSTAT CORPORATION OF AMERICA

10 East 39th Street, New York 16, N. Y.
Representatives in Principal Cities

AC1969

SERV-RITE
DRILLED WELLS

thermometer sockets
thermometer test wells
thermocouple wells

FOR PLUS SERVICE

SERV-RITE drilled protecting wells are made in types, lengths, and of alloys to meet any temperature and pressure condition in vessels and flow lines.

Every well is carefully made to assure a plus service. Selected bar stock is machined to within accurate limits. Bore concentricity is held within 5% of wall thickness, depending on well length. They are tested to withstand pressures up to 3000 psi., depending on the wall thickness. Exterior surface has a mirror-like finish for minimum resistance to flow in lines.

Complete assemblies can also be furnished with suitable thermocouple, head, flange, fittings, etc.

Give SERV-RITE a trial on your next drilled well requirements. There is none better.

Write for Bulletin No. 2000
for specifications, size, and ordering information on SERV-RITE drilled wells.

8640

CLAUD S. GORDON CO.
Manufacturers • Engineers • Distributors

615 West 30th Street, Chicago 16, Illinois
2019 Hamilton Avenue, Cleveland 14, Ohio

Meetings Calendar

Aug.	
9–12	**American Society of Mechanical Engineers,** Heat Transfer Conference, University of Connecticut, Storrs.
10–13	**Society of Automotive Engineers,** National West Coast Meeting, Hotel Georgia, Vancouver, B.C.
23–26	**American Institute of Electrical Engineers,** Petroleum Industry Electrical Conference, Wilton Hotel, Long Beach, Calif.
Sept.	
2– 4	**Cryogenic Engineering Conference,** University of California, Berkeley.
9–10	**ASME,** International Congress on Air Pollution, New York.
13–18	**American Chemical Society,** National Meeting, Atlantic City.
16–18	**National Petroleum Association,** Annual Meeting, Traymore Hotel, Atlantic City.
17–	**Natural Gasoline Association of America,** Rocky Mountain Regional Meeting, Casper Wyo. or Calgary, Alberta.
20–23	**ASME,** Petroleum Mechanical Engineering Conference, Rice Hotel, Houston.
21–25	**Instrument Society of America,** Annual Instrumentation-Automation Conference and Exhibit, International Amphitheater, Chicago.
22–24	**Industrial Nuclear Technology Conference,** Morrison Hotel, Chicago.
23–24	**Western Petroleum Refiners Association,** Rocky Mountain Technical-Industrial Relations Meeting, Henning Hotel, Casper.
27–30	**American Institute of Chemical Engineers,** Meeting, Hotel St. Paul, St. Paul.
28–30	**American Oil Chemists Society Meeting,** Hotel Statler, Los Angeles.
29–30	**WPRA,** Management Seminar, Western Hills Hotel, Wagoner, Okla.
28-Oct 1	**American Welding Society,** Fall Meeting, Sheraton-Cadillac Hotel, Detroit.
29-Oct 1	**National Association of Corrosion Engineers,** Western Region Conference, Bakersfield Inn, Bakersfield, Calif.
Oct.	
5– 8	**NACE,** Northeast Region Conference, Lord Baltimore Hotel, Baltimore.
7– 8	**WPRA,** Annual Stream Pollution and Waste Disposal Conference, Broadview Hotel, Wichita.
8– 9	**California Natural Gasoline Association,** Fall Meeting, Huntington-Sheraton Hotel, Pasadena, Calif.
11–16	**American Society for Testing Materials,** Pacific Area National Meeting, Sheraton-Palace Hotel, San Francisco.
12–14	**National Electronics Conference,** Hotel Sherman, Chicago.
20–22	**American Standards Association,** National Conference on Standards, Sheraton-Cadillac Hotel, Detroit.
20–22	**ASME-ASLE,** Lubrication Conference, Sheraton-McAlphin, New York.
20–22	**NACE,** North Central Region Conference, Cleveland.
23–	**NGAA,** Southern Regional Meeting, Carlton Hotel, Tyler, Texas.
26–28	**National Lubricating Grease Institute,** Annual Meeting, Roosevelt Hotel, New Orleans.
28–29	**Computer Applications Symposium,** Morriston Hotel, Chicago.
28–29	**WPRA,** Question and Answer Session on Refining Technology, Rufus Garrett Hotel, El Dorado, Ark.
28–30	**Society of Automotive Engineers,** National Fuels and Lubricants Meeting, La Salle Hotel, Chicago.
30	**AIChE,** South Texas Section Technical Meeting, Moody Center, Galveston, Texas.
Nov.	
4– 6	**Institute of Radio Engineers,** National Automatic Control Conference, Sheraton Hotel, Dallas.
9–11	**American Petroleum Institute,** Annual Meeting, Conrad Hilton, Palmer House, and Congress Hotels, Chicago.
11–13	**National Fire Protection Association,** Fall Conference, Hotel Fort Des Moines, Des Moines.
16–20	**International Automation Exposition and Congress,** New York Trade Show Building, New York.
17–18	**WPRA,** Computer Conference.
20–	**NGAA,** Panhandle-Plains Regional Meeting, Herring Hotel, Amarillo.
29-Dec4	**ASME,** Annual Meeting, Chalfonte Haddon Hall, Atlantic City.
30-Dec4	**Exposition of Chemical Industries,** New York Coliseum.
Jan. 1960	
22–	**NGAA,** Gulf Coast Regional Meeting, Robert Driscoll Hotel, Corpus Christi.
Feb.	
1–5	**ASTM,** Committee Week, Hotel Sherman, Chicago.
26–	**NGAA,** Permian Basin Regional Meeting, Lincoln Hotel, Odessa, Texas.
March	
14–18	**NACE,** Annual Meeting, Memorial Auditorium, Dallas.
18–	**NGAA,** Oklahoma Regional Meeting, Biltmore Hotel, Oklahoma City.
April	
19–21	**Southwestern Gas Measurement Short Course,** Drill Hall, North Campus, University of Oklahoma.
20–22	**National Petroleum Association,** Semiannual Meeting, Hotel Cleveland, Cleveland.

Men In Industry...

Schweppe

Ritter

Lenoir

ASEE Nomograph Award Won By Petroleum Refiner Authors

Joseph L. Schweppe, R. Brown Ritter and John M. Lenoir have received a $100 award for nomographs published in the November, 1958, PETROLEUM REFINER, pages 225-232. Schweppe is an associate professor of mechanical engineering at the University of Houston, and Ritter and Lenoir are engineers for C F Braun & Co. The award was contributed by Convair Aircraft Corp., San Diego, through the American Society for Engineering Education's Division of Engineering Graphics. It was divided equally between the three authors. The winning nomograph is entitled "Specific Gravity of Petroleum Fractions."

Kenneth C. Peterson has been named a section leader at Whiting Research Laboratories, Standard Oil Co. (Ind.). His section is responsible for pilot-plant and laboratory development of plastics. He was previously in charge of a design and process engineering group. Peterson has B.S. and M.S. degrees in chemical engineering from the University of Wisconsin. He is a member of ACS.

M. E. Gillis has been promoted to senior chemical engineer in the Technical Division, Humble Oil & Refining Co.'s Baytown, Texas, refinery. He handles projects involving the production of Butyl rubber. Gillis has a B.S. degree in chemical engineering from The University of Texas.

G. H. Weisemann has been named director of chemicals development at Whiting Research Laboratories, Standard Oil Co. (Ind.). Weisemann has had experience in the work his division carries out, having supervised pilot-plant and design work in new processes, both for chemicals and petroleum products. He was most recently a section leader in chemicals development, and had an important part in the design of an Amoco Chemicals Corp. plant. Weisemann obtained his B.S. degree in chemical engineering at Iowa State College. He is a member of ACS, AIChE and the Society of Plastics Engineers.

Herbert N. Friedlander has been named a section leader at Whiting Research Laboratories, Standard Oil Co. (Ind.). He will be in charge of laboratory research on new and improved plastics. Since he joined Standard in 1948, much of Dr. Friedlander's work has been devoted to plastics research. He has a Ph.D. degree in chemistry from the University of Chicago, where he completed undergraduate study. He is a member of ACS, Phi Beta Kappa and Sigma Xi.

Ben C. Ball, supervisor of the bulk oil shipping unit at Gulf Oil Corp.'s Port Arthur refinery, has transferred to the Houston staff of **B. H. Barnes,** vice president in charge of domestic manufacturing. Ball's new assignment will be in cost and economics studies on the departmental level. Holder of B.S. and M.S. degrees in chemical engineering, he joined Gulf at the Port Arthur refinery in July, 1949.

W. K. Venatta has been named manager of Oronite Chemical Co.'s Manufacturing Department, San Francisco. He joined Oronite in 1948 and for the past two years has been manager of the company's Oak Point, La., plant. Before that, he was with California Research Corp. Venatta is a chemical engineering graduate of the University of Wisconsin.

James F. Bell has been named manager of General Petroleum Corp.'s new Petroleum Chemicals Department. Before joining General Petroleum, he was executive vice president of Northwest Natural Gas Co., Portland. He joined Northwest Gas in 1946 as assistant to the president. Holder of an A.B. degree in engineering from Stanford University, he completed his doctorate in geology at the University of Munich in 1935. Bell has been active in AGA and Pacific Coast Gas Association.

J. L. Porter has been appointed petrochemical advisor to The British American Oil Co., Ltd.'s Manufacturing Department, Toronto. He holds a M.S. degree in chemical engineering from Virginia Polytechnic Institute. Porter joined B-A in 1934 and has worked at the Montreal, Toronto, Calgary, Moose Jaw and Clarkson refineries. Since 1954, he has been head process engineer in the Manufacturing Department, head office.

D. C. Lennon, a senior chemical sales engineer of Humphreys & Glasgow, Ltd. of London, has been appointed a director of Societe de Construction d'Appareils pour Gaz a l'Eau et Gaz Industriel, an associate company. He joined Humphreys & Glasgow in June, 1957, after spending a year in the United States. Previously he was a process and sales engineer for Foster Wheeler, Ltd., in the United Kingdom and the United States.

Harold F. Elkin has been appointed engineering consultant to coordinate all pollution control measures for Sun Oil Co. He had been with Sun's Research and Engineering Department as sanitation engineer since 1954. Recently, Elkin was appointed by the Federal Government as one of two representatives from the petroleum industry to serve on the National Technical Task Committee on Industrial Wastes.

J. Kenneth Koster has been named manager of production and engineering at the Calvert City, Ky., general chemical plant of B. F. Goodrich Chemical Co. Previously he was manager of construction. Koster joined Goodrich in 1940 at the Cadillac, Mich., plant. He has since worked in a number of Goodrich plants. His last position was in Cleveland as manager of construction. Koster attended Lamar College in Beaumont, Texas, and is a member of AIChE.

Dr. Norman P. Neureiter, a research chemist at Humble Oil & Refining Co.'s Baytown refinery, is one of 75 guides selected for the American National Exhibition opening in Moscow July 25. The guides were chosen by special selection boards and are mostly college and post-graduate students majoring in Soviet studies who are well-versed in U.S. and

A-W crane carries 5000-lb. gate valve through low warehouse doorway. Crane requires minimum 10½-ft. overhead clearance.

Seven A-W cranes help Atlantic Refining reduce maintenance costs

"Since 1956, we have reduced the cost of crane maintenance by about 30% through the use of A-W equipment," says Walter O. Hoffman, general superintendent of Atlantic Refining Company's service division, Philadelphia, Pa.

Fast, highly maneuverable

As a result of a careful evaluation of crane performance in every maintenance operation, Atlantic Refining now has a fleet of six self-propelled, rubber-tired cranes and one truck-mounted unit.

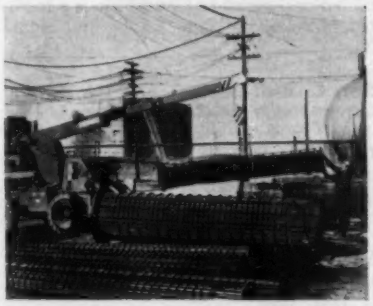
These highly maneuverable cranes, with all-wheel steering, work close to equipment, travel at traffic speeds, and pass under overhead obstructions as low as 10½ ft.

The A-W's handle 75% of all lifting jobs in the refinery. For instance, an A-W can lift out an exchanger bundle, carry it to the repair shop, position it for mechanics, and later reverse the process to speed installation of the repaired unit.

Mr. Hoffman adds, "The efficiency of our maintenance force depends greatly on the efficiency of the equipment it has to work with. The adoption and use of the Austin-Western hydraulic cranes is an example of our continuing effort to provide the most efficient equipment available!"

Reduce your costs

Learn how all-wheel drive and all-wheel steer A-W cranes can reduce maintenance and handling costs in your operation. Complete crane line now available—varying capacity ranges and boom lengths. Get all the facts today from your nearby Austin-Western distributor or write us direct.



Precision hydraulic control simplifies removal, handling, repair and maintenance of delicate heat exchanger bundles.

Austin 1859 AUSTIN-WESTERN 1959 100th YEAR PARTNERS IN PROGRESS Western
CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.
BALDWIN · LIMA · HAMILTON
Power graders • Motor sweepers • Road rollers • Hydraulic cranes

Men . . .

Soviet affairs. Dr. Neureiter teaches Russian in evening classes at the University of Houston. He holds an A.B. degree in chemistry from the University of Rochester and a Ph.D. degree from Northwestern University.

Dr. Gus E. Montes has joined Northern Natural Gas Co. as technical director, Gas Products Development Department. He will be responsible for all technical phases in the development of gas products. Dr. Montes formerly was with U.S. Industrial Chemicals Corp., Tuscola, Ill., where he was chief technologist. He has Ph.D., M.S. and B.S. degrees in chemical engineering from the University of Texas at Austin. Formerly chairman of the Central Illinois Chapter of AIChE, he has been active on several committees of the national organization.

Montes

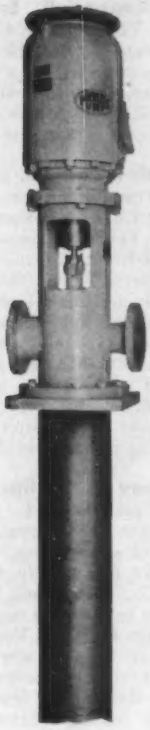
Maurycy Bloch has been named president of Western Petrochemical Corp. Formerly vice president and general manager of Warwick Wax Co., recently acquired from Sun Chemical Corp. by Western, Bloch will also be chief executive, Warwick Division. He joined Warwick in 1944, and in 1946 became Midwestern sales manager. Two years later he became national sales manager, and in 1949 was named vice president. In 1950, Bloch was named general manager and director.

Bloch

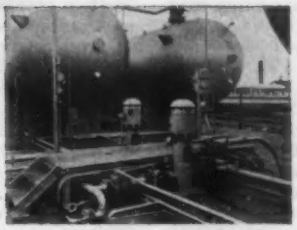
John A. Boege has been appointed assistant to the director of manufacturing by General Petroleum Corp. Boege joined General Petroleum in 1930 as an inspector at the Torrance refinery. He had been manager of the Manufacturing Department's Vernon headquarters since 1953. He has been a chemist, senior chemical engineer, chemical engineer first class, process engineer, general superintendent of the Laboratories Department and manager of the department.

William P. Schoentgen has been named manager of employe communications, Public Relations Department, Standard Oil Co. (Indiana). He has been an advanced writer in the department, and was formerly editor of the employe magazine, *Standard Torch*. He joined Standard in 1954, having been feature editor of a magazine, managing editor of a news feature service, and editor of the Sheldon, Iowa, *Sun*.

to quench a big thirst–



PEERLESS PUMP



"Fill it up!" and nearly 60 million automobiles take an annual 56 billion gallon drink. Helping to "set 'em up again" for aircraft, automobiles, L-P gas and diesel engines, virtually every type transportation, is the Peerless Hydro-Line® vertical pump. Available in two basic types, process and transfer, the Peerless Hydro-Line is serving in the handling of hydrocarbons such as gasoline, butane, propane, hot oils, etc.; hot or cold water; mild acids, basic and salt solutions. This flexibility of application, plus its space-saving vertical design, its outstanding NPSH (net positive suction head) characteristics and its ready adaptability to future system requirements, has made the Peerless Hydro-Line truly one of America's most versatile pumps. For complete information on the Peerless Hydro-Line vertical pump line, write for Bulletin No. B-1700.

Putting Ideas to Work

fmc FOOD MACHINERY AND CHEMICAL CORPORATION ®

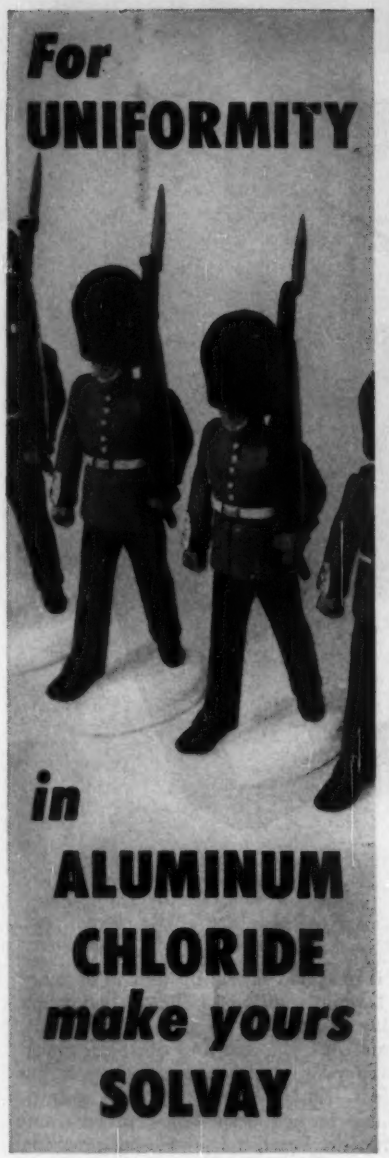
FOOD MACHINERY AND CHEMICAL CORPORATION

Peerless Pump Division

Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA

Offices: New York; Atlanta; St. Louis; Phoenix; San Francisco; Chicago; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque. Distributors in Principal Cities. Consult your telephone directory.

For more data on advertised products, use Readers' Service Cards, last page.



Uniformity of product is one of the many sound reasons for specifying SOLVAY Aluminum Chloride. Quality, service, dependability, purity are other important considerations.

Write for literature, prices, specific information.

Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, N.Y. 6, N.Y.

Branch Sales Offices:
Boston • Charlotte • Chicago • Cincinnati • Cleveland
Detroit • Houston • New Orleans • New York
Philadelphia • Pittsburgh • St. Louis • Syracuse

Men . . .

Peter R. McArthur has joined The Ralph M. Parsons Co. to manage business development in the petroleum, chemical, and petrochemical industries. A graduate engineer, McArthur had worked in a similar capacity.

Keith G. Blanchard has been elected vice president of Tuloma Gas Products Co., Tulsa. He was previously a Standard Oil Co. (Indiana) district manager, and had been with the company for 29 years. Blanchard attended Millikin University.

William Thompson, formerly assistant chief inspector with The Fluor Corp., Ltd., has been named chief inspector. He joined Fluor in 1951, and in 1953 was appointed assistant chief inspector.

Burton B. Sandiford has been promoted to senior research chemist at the Union Research Center, Brea, Calif., along with **Grant W. Hendricks** and **Dr. Edward P. Parry.**

Richard C. McCurdy, president of Shell Chemical Corp. and a director of Shell Oil Co., has been elected a member of the executive committee, Shell Oil.

Dr. Eugene R. Smoley, vice president, The Lummus Co., has retired after 25 years' service. He will continue as a sales consultant on a part time basis. Dr. Smoley plans to continue his work with AIChE, with which he just completed two years as national program chairman.

Ralph N. Rouse, a former member of the Training Section at Magnolia Petroleum Co.'s Beaumont refinery, has become training supervisor at a new Mobil-International Oil Co., refinery in Venezuela. The 50,000-bpd plant is being constructed near Puerto Cabello on the Caribbean Sea. Rouse was transferred recently to Mobil International, having been with Magnolia since 1937. He began in the office, later worked in the instrument shop, and was transferred to Employe Relations Department as a training assistant in 1952.

Sydney M. Stoller, engineering manager, and **Jack L. Schumann,** sales manager, have been named vice president of engineering, and vice president of sales, respectively, for Vitro Engineering Co., New York. Stoller has a B.S. degree in chemical engineering from City College of New York. Before joining Vitro in 1948, he was a process engineer with Foster Wheeler Corp. Schumann has a B.S. degree from Yale University. Before joining Vitro in 1956 as sales manager, he was with National Meter Division, Rockwell Manufacturing Co. and Buell Engineering Co.

Dr. Benjamin R. Teare, Jr., dean of the College of Engineering and Science at Carnegie Institute of Technology, is president-elect of the American Society for Engineering Education. He will serve from June, 1959 to June, 1960. **Dr. Ralph G. Owens,** dean of engineering at Illinois Institute of Technology, Chicago, is vice president for general and regional activities East of the Mississippi River, 1959-61. **Dr. Howard W. Barlow,** director of Washington State Institute of Technology at Washington State University is vice president for general divisions and committees, 1959-61. **Wendel W. Burton,** employment manager for Minnesota Mining and Manufacturing Co., Minneapolis, is treasurer of the Society, 1959-60.

John J. Griffin has been appointed chief engineer of Petro-Chem Development Co., Inc. With the company since 1954, he was formerly manager of the Service Department. Before joining Petro-Chem, he had been chief engineer with National Airoil Burner Co., Philadelphia. Griffin is a graduate of Mount Mary's College with a B.S. degree. He is a registered professional engineer in New York and is an active member of ASME.

Griffin

Edward L. Steiniger, president and director of Sinclair Oil Corp., has been named to the board of lay trustees, Fordham University. He is a director of API, a member of the Pan-American Society, the Newcomen Society and the Economic Club of New York and is a board member, National Industrial Conference board. The board of lay trustees will be the principal lay board of the university.

Steiniger

James B. Weaver has received the AACE "Award of Merit," 1959, for his work in preparing an annual bibliography of cost engineering articles, books and other publications. A chemical engineer with B.S. and M.S. degrees from M.I.T., he is manager of economic evaluation, Atlas Powder Co., Wilmington. For a year he taught at M.I.T., then spent five years as assistant to the director of research and development, Godfrey L. Cabot, Inc. During the five years before he joined Atlas in 1954, Weaver was a techno-economist and later section chief in the research department of Olin Industries, Inc.

Weaver

STOP! And Consider These Authoritative Books

ADVANCES IN PETROLEUM CHEMISTRY AND REFINING (VOL. I)

Edited by Kenneth A. Kobe and John J. McKetta

Presents recent advances in the petroleum and petrochemicals industry. Subject matter was prepared and written by outstanding industry authorities.

CONTENTS (Condensed). Group I. Economics and Future Trends: Petroleum Operations In The U. S., by Richard J. Gonzalez; Present and Future Sources and Compositions, by Harold Gershinowitz; Fuel Trends, by Harold A. Beatty and Wheeler G. Lovell. Group II. Unit Operations and Designs: Separation and Purification By Crystallization, by Robert A. Findlay and John A. Weedman; Superfractionization, Azeotropic and Extractive Distillation, by S. B. Zdonik; New Fractionating-Tray Designs, by Frank J. Lockhart and C. W. Leggett. Group III. Refining Processes: Alkylation of Paraffins, by John O. Iverson and Louis Schmerling; Catalytic Reforming, by Vladimir Haensel and C. V. Berger; Solvent Refining, by Alfred W. Francis and William H. King. Group IV. Petrochemicals: The Oxo Processes, by Alexis Voorhies, Jr., John J. Owen and John F. Johnson; Solid Polymers From Surface Catalysts, by Herbert N. Friedlander and William Resnick. Group V. Mechanical Equipment: Power Plants of the Future, by C. G. A. Rosen.

1958, 656 pages, 131 illus., 86 tables.....Price $13.50

PETROLEUM REFINING WITH CHEMICALS

By Vladimir A. Kalichevsky and Kenneth A. Kobe

Provides a comprehensive treatise explaining the various problems encountered in refining and finishing petroleum products. Detailed explanations are given on petroleum refining with chemicals and solvents, use of additives for improving quality of petroleum products, modern testing methods and their interpretations, concept of color (as applied to color of petroleum oils, etc.), as well as other theories such as lubrication, viscosity, surface tension, vapor pressure, boiling point, fire and flash point, octane number, etc. The extensive use of thousands of patents on subjects covered and the wealth of reference to the literature are of particular value.

1956, 700 pages, illustrated.....Price $17.50

PETROLEUM DICTIONARY

By Hollis P. Porter

A valuable book for office, field and plant. Beginners in the oil industry (young technicians, secretarial and clerical) and old-hands in the oil business will find the Petroleum Dictionary to be of real interest and value to them. It is convenient to use, easy-to-read and understand. No other work of a similar nature compares with its thoroughness and dependability. It will be a valuable adjunct to the libraries of executives, engineers, students of the oil industry —in fact anyone who is in anyway connected with or interested in the petroleum industry.

1948, 326 pages.....Price $6.00

VOLUMETRIC AND PHASE BEHAVIOR OF HYDROCARBONS

By Bruce H. Sage and William N. Lacey

Book considers fundamental principles and facts relating to hydrocarbon behavior not involving chemical reactions or changes in molecular species present. Subject matter is developed in a logical manner, without assuming the reader has made intensive studies of physical chemistry.

CONTENTS (Condensed). Introduction: Hydrocarbon Series, General Definitions, Equilibrium. Mathematical Concepts: Analytical and Graphical Methods, Graphical Differentiation. Behavior of Pure Substances: Phase and General Behavior, Gases, Liquids, Critical Region. Two-Component Systems: Single- and Two-Phase Regions, Critical Behavior of Mixtures, Effect of Pressure, Temperature and Composition on Volume, Constant Boiling Mixtures, Partly Miscible Liquids, Condensed Systems, Two-Phase and Critical Regions, Systems of Variable Composition, Effect of Composition on Dew- and Bubble-Point Pressure and on Volume of Ternary Systems, Condensed and Liquid-Gas Systems. Multi-Component Systems: Composition, Two-Phase Region for Systems of Constant Composition, Materials of Restricted Boiling Range, Gas-Cap Materials, Mixture of Crude Oil and Natural Gas, Composition of Coexisting Phases, Systems of Variable Weight. Phase Rule. Partial Quantities: Ternary and Multi-Component Systems, Apparent Partial Quantities. Ideal Solutions: Fugacity, Raoult's Law, Deviations From Ideal Solutions and Raoult's Law, Phase Behavior at Higher Pressures.

1949, 299 pages, illustrated.....Price $5.00

THE CHEMISTRY OF PETROCHEMICAL REACTIONS

By Lewis F. Hatch

This completely indexed volume provides a thorough, exhaustive treatise of reactions and processing of petrochemicals. It is an immediate reference for anyone engaged in the chemical or refining industry. In addition to technical data, valuable commentaries on end use and market of many significant chemicals are presented in a manner that makes this book a practical working manual.

CONTENTS (Condensed). Petroleum as a Raw Material for the Chemical Industry, Non-Hydrocarbon Constituents of Petroleum (Sulfur, Nitrogen and Oxygen Compounds). Oxydation of Hydrocarbons. Chlorination, Nitration and Sulfonation of Paraffin and Aromatic Hydrocarbons. Production and Reaction of Olefins. Alcohols from Olefins. Halogenation, Oxidation, Alkylation and Polymerization of Olefins. The Oxo Reaction-Primary Alcohols from Olefins. The Production and Reactions of Butadiene. Preparation and Properties of Acetylene, Air and Methane.

1955, 192 pages, illustrated.....Price $4.50

The GULF PUBLISHING COMPANY, P. O. Box 2608, Houston 1, Texas

Send Me: ____Copies of Vol. I, Advances In Petroleum Chemistry and Refining, Price $13.50 a copy.
____Copies of Petroleum Refining With Chemicals, Price $17.50 a copy.
____Copies of The Chemistry Of Petrochemical Reactions, Price $4.50 a copy.
____Copies of Volumetric & Phase Behavior of Hydrocarbons, Price $5.00 a copy.
____Copies of Petroleum Dictionary, Price $6.00 a copy.

☐ My Check Enclosed — I Save Fostage ☐ Bill Me ☐ Bill My Company
☐ 10-Day Free Examination ☐ Send Free Book Catalog

Name_____ Position_____
Company_____
Address ☐ Home ☐ Office_____
City_____ Zone____ State_____
Pro-Forma Invoice Outside the U. S.

35 years of continuous advertising

The advertising on the facing page marks an historic milestone for this publication and for a company whose name is familiar to all PETROLEUM REFINER readers throughout the world.

Thirty-five years ago few persons could visualize the magnitude, worldwide scope and remarkable technical developments of the oil, gas and petrochemical processing industry as we know it today.

Continuously, month after month during these 35 years, Elliott Company advertisements have kept petroleum refining men informed of the equipment with which Elliott serves this vital industry.

This month marks the 420th consecutive issue of PETROLEUM REFINER in which Elliott Company has carried one or more advertisements. We salute a company whose continuous advertising program is a mark of both stability and progressiveness!

Petroleum Refiner
for the OIL, GAS AND PETROCHEMICAL PROCESSING INDUSTRY
Houston 1, Texas

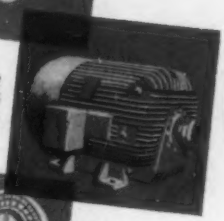
TURBINE-GENERATORS

STEAM AND GAS TURBINES (mechanical drive, power recovery)

DEAERATING FEEDWATER HEATERS

STEAM JET EJECTORS

TURBOCHARGERS (for 2-cycle and 4-cycle engines)



CROCKER-WHEELER MOTORS (1 hp to 300 hp)

LARGE MOTORS AND GENERATORS

TUBE CLEANERS AND EXPANDERS

STRAINERS AND FILTERS

CENTRIFUGAL COMPRESSORS

Progressive engineering and research at Elliott

have developed many specialized products for petroleum refineries

An outstanding example is power recovery equipment. For many years Elliott engineers have been perfecting methods of putting hot process gases to work. This experience has resulted in a new line of process gas turbine-compressors developed especially for application to fluid catalytic crackers. Utilizing energy from the hot waste gases, this equipment permits substantial saving in the power cost of compression.

Another recent Elliott development is a compact, low-flow, high-head centrifugal oxygen compressor. Specially designed aluminum oxide bearings are water lubricated, reducing explosion hazard and eliminating lube oil contamination.

Elliott's famous line of ribbed-frame Sealedpower motors, pioneered in the United States by our Crocker-Wheeler plant, are now available in enclosed and explosion-proof frames up to 300 hp.

Other Elliott accomplishments over the years include tube cleaners, introduced when pipe stills first appeared on the scene; steam jet ejectors for maintaining vacuum on stills; steam turbines for safe and efficient drives all around the refinery; centrifugal compressors; condensers, of all types and sizes; deaerating feedwater heaters; turbochargers for getting more power out of diesel and gas engines; a line of effective single, twin, and self-cleaning strainers; tube expanders and tube accessories. All of these have grown with the refinery industry, have served and are serving it well.

Sixty years of distinguished performance in the petroleum industry

ELLIOTT Company
Jeannette, Pennsylvania

Q9-5

Creole Petroleum Corporation of Venezuela, one of the world's largest producers of crude oil, has pursued a dedicated course of conservation and maximum utilization of Venezuela's natural resources. In so doing, complex engineering problems in gas injection have been created.

An organization of the magnitude of Creole can readily command the very best engineering and construction talent available . . . and Brown & Root felt signally honored when in 1952 they were awarded a contract to design and construct a 60,000 horsepower gas injection station, to be located 7 miles from shore in Lake Maracaibo. The job was loaded with "firsts" and superlatives. For example, it was the first time centrifugal compressors were ever used to compress gas to 2000 p.s.i. This tremendous amount of horsepower was to be housed on a platform in 62 feet of water, with all the related problems of vibration, corrosion, noise and self-containment.

Evidence that the client was pleased with this $20 million project came when Brown & Root was awarded a contract to design and construct Conservation Plant Tía Juana Two of 84,000 horsepower, and then again Brown & Root was successful in obtaining the design and construction contracts for Tía Juana Plant Three of 98,000 horsepower. Conservation Plant Bachaquero One, Creole's fourth repressuring station, is currently on Brown & Root's drawing boards.

BROWN & ROOT, INC. *Engineers - Constructors*

POST OFFICE BOX 3, HOUSTON 1, TEXAS

Brown & Root, S. A., Panama City, Panama
No. One Wall Street, New York 5, New York
P. O. Box 4140, South Station, Edmonton, Alberta
Pennsylvania Building, Washington, D. C.
Brown & Root Construcciones, S. A., Caracas, Venezuela
Brown & Root de Mexico, S. A. de C. V., Mexico City, Mexico
Brown & Root, LTDA., Santos, Sao Paulo, Brazil
CABLE ADDRESS – BROWNBILT

Men . . .

Harry R.
fices as a
light hydr
leum indu
president
loma Gas
offices in t

Rufus T.
have been
Vacuum
members h
56 years
Burton has
dent at Sta
ters near
the compa
New Zeala
he filled
Pakistan,
a petroleu
A graduat
chanical e
now the
Holst, wh
Economic
Stanvac's h
at the co
bang, Sun
in 1934.

Frederic
charge of
Technical
vice presi
Departme
who has
president
Departme
as vice p
nical Dep
president
Departme
charge of
Holmes g
with a P
spent mo
Texaco
joined the
ating fro
a B.S. de
Gee studi
and at M
nology. H
research

J. H. Fo
president
Commonw
active in
of AIEE
president
Commonw
Mich. A
1918, Fo
president
ber of ma
istrative
several.

John H.
assistant
Standard
ton Univ
company
of Iran

July, 19

Men . . .

Harry R. Thomas has established offices as a management consultant to the light hydrocarbons branch of the petroleum industry. He has resigned as vice president and general manager of Tuloma Gas Products Co., and maintains offices in the Enterprise Building, Tulsa.

Rufus T. Burton and Willem Holst have been elected directors of Standard-Vacuum Oil Co. The two new board members have combined service of nearly 56 years with Stanvac. Since last July, Burton has been the regional vice president at Stanvac's international headquarters near White Plains, responsible for the company's interests in Australia and New Zealand. For more than 20 years, he filled overseas assignments in India, Pakistan, Ceylon and the Philippines as a petroleum marketer and administrator. A graduate of Purdue University in mechanical engineering, he joined what is now the Stanvac organization in 1930. Holst, who has been manager of the Economic Coordination department at Stanvac's headquarters since 1946, started at the company's refinery near Palembang, Sumatra, as a chemical engineer in 1934.

Frederic H. Holmes, vice president in charge of Texaco Inc.'s Research and Technical Department, has been named vice president in charge of the Refining Department succeeding **John S. Worden,** who has retired. **L. C. Kemp, Jr.,** vice president in charge of the Petrochemical Department (Domestic), succeeds Holmes as vice president, Research and Technical Department. **William P. Gee,** vice president in charge of the Petrochemical Department (Foreign), will also be in charge of Petrochemicals, Domestic. Holmes graduated from Yale University with a Ph.B. degree in 1927, and has spent most of his 32-year career with Texaco in refinery operations. Kemp joined the company shortly after graduating from Rice Institute in 1929 with a B.S. degree in chemical engineering. Gee studied at the University of Texas and at Massachusetts Institute of Technology. He joined Texaco in 1927 as a research chemist.

J. H. Foote has been elected 1959-60 president of AIEE. Chief engineer of Commonwealth Associates, he has been active in national and Michigan affairs of AIEE for many years. He also is vice president and director of engineering for Commonwealth Services Inc., Jackson, Mich. A member of the Institute since 1918, Foote completed a term as vice president in 1958. He has been a member of many AIEE technical and administrative committees and chairman of several.

John H. Thacher, Jr., has been named assistant to the chairman of the board, Standard Oil Co. of California. A Princeton University graduate, he joined the company in 1930. He has been president of Iran California Oil Co., a Standard

Air hoist runs cool
despite heat and humidity

Maintenance of processing equipment calls for steam, plus a hoist that laughs at constant heat and humidity. That's why so many chemical plants and refineries favor this ½-ton Gardner-Denver 86-1V10, air hoist (one of our complete line with capacities from 150 lb. to two tons). Reasons for this preference for Gardner-Denver hoists include: fire-safe, nonsparking operation; they provide a positive, steady lift; they possess every other feature required for easy, safe load spotting. Write for Bulletin 86-1.

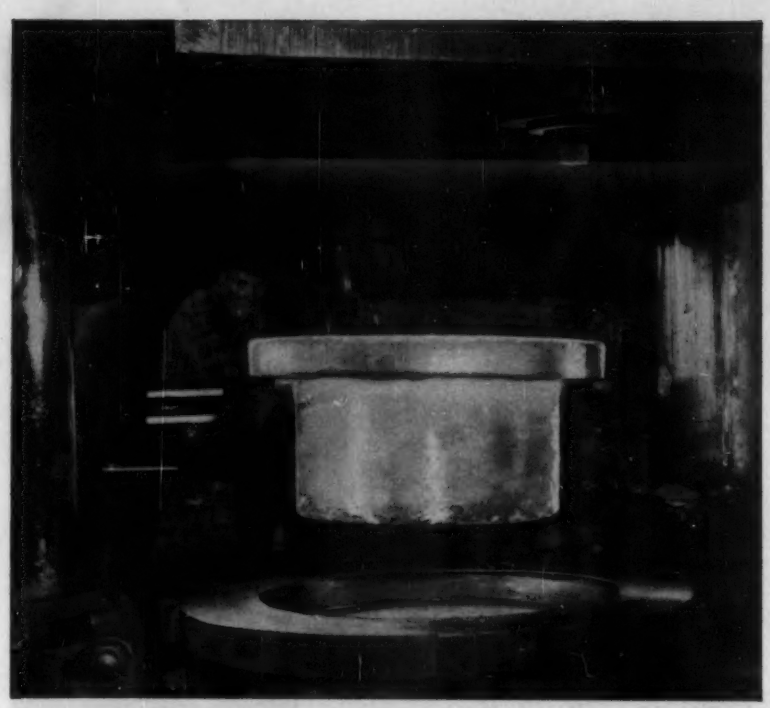
EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

For more data on advertised products, use Readers' Service Cards, last page.



IN **LENAPE** WELDING CONNECTIONS,
YOU MAKE THE CHOICE

For pressure vessels, Lenape gives you the widest choice of seamless forged welding connections that meet your requirements for:

TYPE—Your choice of Seamless Long Welding Necks; Type H Heavy Reinforcing Necks; Studding Outlets; Type S Nozzles; new Seamless Welding Extensions; Internal or External Reinforced Nozzles; ASA Flanges and new Dished Blind Flanges.

MATERIAL—Your choice of carbon steels, T-1, high temperature-low alloy and stainless compositions.

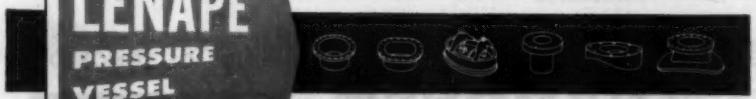
SIZE-PRESSURE CLASS—Your choice of size and pressure class that meet all ASME requirements.

LOW COST. Specialized manufacturing techniques make even standard LENAPE Seamless Welding Necks cheaper than fabricated necks in most sizes—plus the wide variety of low cost connections available exclusively from LENAPE.

Write today for full information about LENAPE Welding Connections.

LENAPE PRESSURE VESSEL CONNECTIONS

See our standard line of pressure vessel connections on pages 1128-1129 in the 1958 Chemical Engineering Catalog.



LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 106 WEST CHESTER, PA.
RED MAN PRODUCTS

Men . . .

subsidiary. Succeeding him will be **Fredric C. Boucke,** formerly manager of the Eastern hemisphere staff, San Francisco, and manager of operations for Irancal and another subsidiary, California Asiatic Oil Co. Boucke is a graduate of the University of California and holds a M.A. degree from Harvard University. He joined Standard in 1937. **George T. Ballou** will assume Boucke's old duties. He has been a vice president of California Commercial Co., a Standard subsidiary in New York. A graduate of San Jose State College and Stanford University, he joined Standard in 1946.

John E. Brewster has been appointed manager of supply and transportation, Commonwealth Oil Refining Co., Inc. He will be in the New York office. Before his appointment, Brewster was Southern Division manager of Indiana Oil Purchasing Co., Tulsa. He attended Arkansas A&M College and entered the oil industry in 1948 with Root Petroleum Co. Before joining Indiana Oil Purchasing he was with Pan-Am Southern Corp., New Orleans.

Brewster

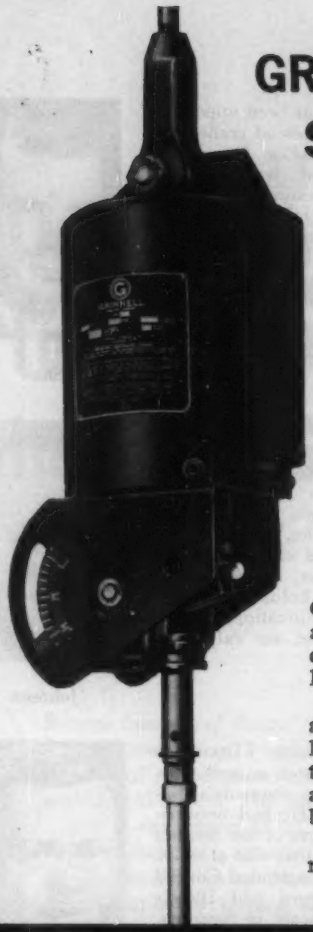
Francis W. Porsche, John W. Shepard and **James O. Knobloch** have been named senior research scientists by Standard Oil Co. (Indiana). New senior project chemists are **Vernon W. Arnold, Peter Fotis, Jr., Roy W. Vander Haar, Arthur W. Sisko, Jarvis B. Beverly, John F. Connolly, Alvin J. Frisque, Fred K. Kawahara** and **R. B. Hannan.** New project chemists are **John D. McCollum, Wayne E. Smith, Eli W. Blaha, T. C. Yao, Albert R. Sabol, Allen E. Brehm, Roger G. Garst, Gordon D. McLeod, Don E. Pickart, Joseph M. Sandri** and **James E. Horan.**

Martin E. Kantor, former instrument engineer with C F Braun & Co., has been appointed a research staff member at John Jay Hopkins Laboratory for Pure and Applied Science, the La Jolla, Calif., facility of General Atomic Division, General Dynamics Corp. Kantor is president of the Southern California Meter Association and ISA.

– Deaths –

LeRoy G. Alexander, 55, Duluth, Minn., vice president and a member of the board of directors of International Refineries, Inc., Wrenshall, Minn., died June 1 in a Duluth hospital. He joined International Refineries in 1951 after serving six years in Venezuela for Creole Petroleum Corp., as a chief engineer and refinery superintendent. He previously worked with Standard Oil Co. (Ohio), Ashland Oil & Refining Co. and Standard Oil Co. (New Jersey).

GRINNELL CONSTANT SUPPORTS...



2 BASIC DESIGNS...

11 DIFFERENT METHODS OF ATTACHMENT

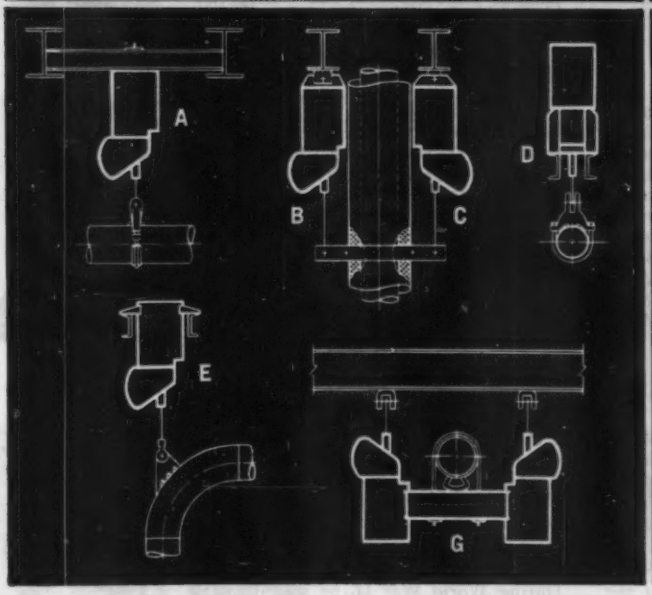
Grinnell Constant Supports are available in a range of sizes to provide capacities for loads from 27 lbs. to 57,500 lbs., with travels up to 16 inches.

Both vertical and horizontal hangers are designed to operate in extremely limited space. In the selection of types, there is a choice of 11 methods of attachment to structures—either above, between, or below supporting steel.

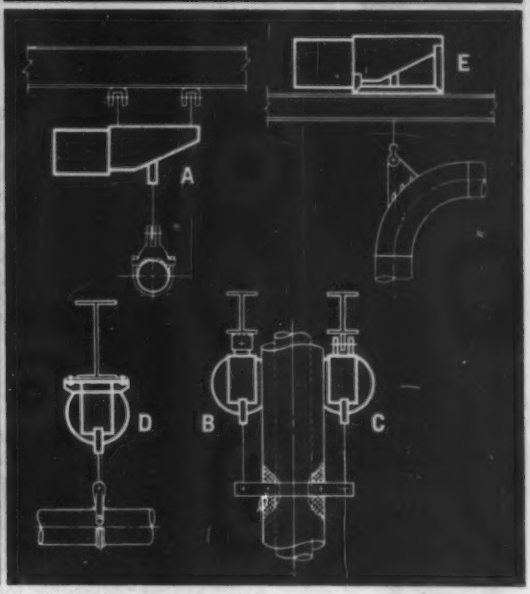
Grinnell Constant Supports provide mathematically perfect load support throughout all positions of travel . . . also a full 70 percentage points of adjustability is built into them. No less than 10% of this adjustability is allowed either side of calibration for plus or minus change in load. Field readjustments are easily made by turning a single load adjustment bolt.

Call on Grinnell's Pipe Suspension Department for help with your pipe suspension problems. Grinnell Company, Providence 1, Rhode Island.

FOR VERTICAL ATTACHMENT



FOR HORIZONTAL ATTACHMENT



GRINNELL

AMERICA'S No. 1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Suppliers Notes...

McLaughlin

Carl B. McLaughlin has been elected president of Tube Turns Plastics, Inc., Louisville, Ky., succeeding **George O. Boomer,** who has become chairman of the executive committee. For 11 years prior to the formation of Tube Turns Plastics, McLaughlin was with what is presently the Tube Turns Division of Chemetron Corp., heading its engineering service. He was a metallurgist-engineer with U.S. Steel Corp., Chicago, from 1934 to 1943.

Cooper

Charles G. Cooper has been named vice president and international director of The Cooper-Bessemer Corp. He is also president and a director of Cooper-Bessemer International Corp., Cooper-Bessemer of Canada, Ltd., and Cooper-Bessemer, S.A. Cooper will be responsible for the integration and organization of these world-wide operations, plus the manufacturing, application and sale of all Cooper-Bessemer products outside the United States.

Hagemeier

Richard Hagemeier has been named a sales representative in the Chicago branch office of Colton Chemical Co., Cleveland. After graduating from Wittenberg College with a chemistry degree, he was with Vanguard Paint Co., Marietta, Ohio, for two years and Schieffelin and Co., New York, for three and a half years as sales supervisor. Hagemeier joined Colton Chemical from the Cleveland branch of McKesson & Robbins Inc., Chemical Division.

Dufford

Donald E. Dufford has been named head of applications engineering at Genesys Corp. He will head a group of process and control computer specialists within the Engineering Department to work closely with customers in determining control requirements and system mechanization. Dufford holds a M.S. degree in applied physics from Harvard University. His career included positions in computation and control with Autonetics, Marquardt Aircraft, and Telecomputing Corp.

Klaus

Richard M. Klaus has been appointed chief engineer at OPW Corp., Cincinnati. A mechanical engineering graduate of the University of Cincinnati, he joined OPW in 1953 as a project engineer. In 1955 he became assistant to the vice president of engineering. In his new position, Klaus will be responsible for the design and development of OPW products. He will also manage OPW's Quality Control Department.

Shew

Frederick B. Shew has been appointed manager of sales, commercial cranes and excavators, by Bucyrus-Erie Co., South Milwaukee, Wis. He had been sales development manager, commercial cranes and excavators, for the last three months. He joined the company in 1956 as a sales representative following a six-year association with Wellman Engineering Co., Cleveland. A native of Indiana, Shew is a graduate of Western Reserve University.

Johnson

Karl Johnson has been named a Jamesbury Corp. sales representative for the St. Louis and Kansas City area. For eight years, Johnson has been with Crane Co. of St. Louis. He was employed in industrial sales, working with architects and engineers in various Midwest industries. Johnson, a graduate of Valparaiso University, holds a B.A. degree in business administration, including two years of study at the Valparaiso School of Engineering.

Quick

Robert M. Quick, with Flexonics Corp. since 1952, has been named marketing manager of the company's Expansion Joint Division. He had been assistant marketing manager of the division since 1956, and before that was a senior project engineer. Quick attended Cornell College and Northwestern and Illinois Universities. He will locate in Savanna, Ill., the headquarters for Flexonics' Expansion Tube Division, and will specialize in pipeline expansion problems.

Conover

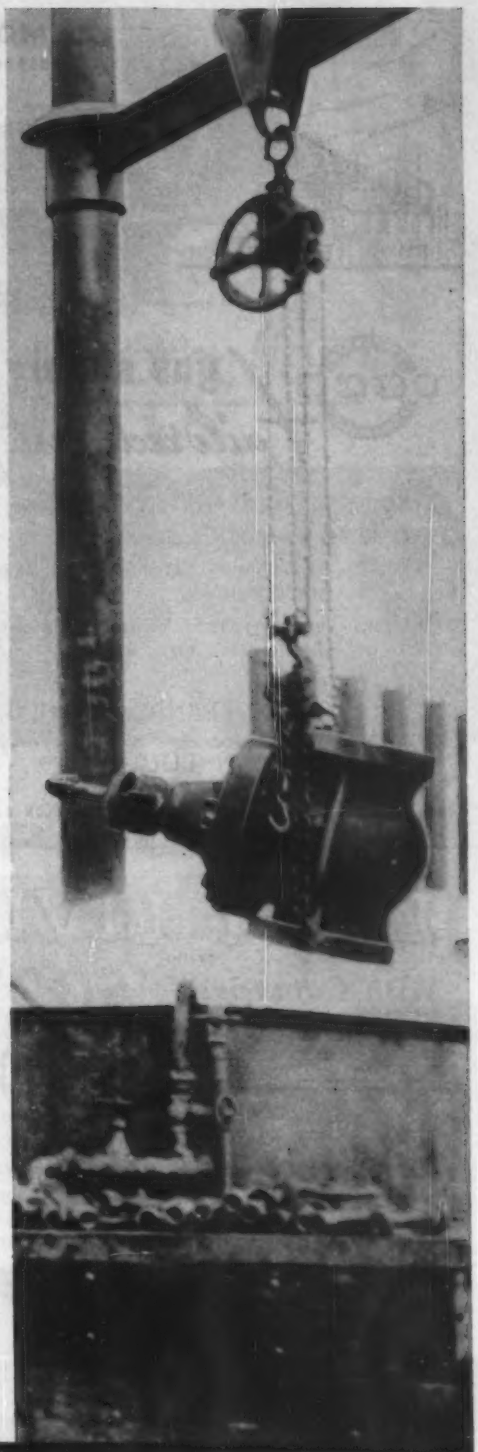
R. C. Conover has been appointed Western District works manager, Refractories Division, H. K. Porter Company, Inc. He will supervise operations of Western District plants at St. Louis, Mo.; Bessemer, Ala.; Ottawa, Ill.; and Canon City, Colo. Conover received a B.S. degree in ceramic engineering from the University of Illinois in 1931, and has been with Harbison-Walker Refractories Co. and Gladding-McBean and Co. as General Manager, Pipe Products Division.

Talmey

Paul Talmey, director of research and development for General American Transportation Corp., has been elected to the board of directors. He began his business career in 1930 after graduating from Yale University, where he majored in physics, mathematics and chemistry. During World War II, he served in the Navy and, on leaving the service in 1945, joined General American. In 1946 he became director of research and de-

Oakite ECP
engineered cleaning program

turns parts salvage into a BIG source of savings



Salvage cleaning of flanges, fittings, valves and other parts formerly took up to 22 hours a batch at one refinery. Heavy deposits of grease, paint, oil and rust were being stripped with a cold solvent. The effort seemed hardly worthwhile.

But in developing an ECP for the refinery, the Oakite engineer included a recommendation to install a permanent salvage cleaning set-up. Now, parts reclamation is a strong contributor to cost control. Work moves as in a "production line"...through special Oakite solutions. Stripping even the worst of soiled batches to bare metal takes only an hour and a half... while material costs have been cut from $1.90 a gallon to less than 58 cents!

WHAT IS OAKITE ECP? It's an *Engineered Cleaning Program* that stresses chemical cleaning. It's engineered specifically for your refinery, for your cleaning problems, and for each cleaning operation—tower by tower, valve by valve.

The Oakite engineer lends personal and experienced supervision to each phase of the program. He supplies detailed instruction based on practical knowledge of refinery cleaning needs. Each Oakite ECP is backed by a *laboratory* concentrating on chemical cleaning research, by *materials* known to make short work of refinery soils, by proved *methods*. Send for booklets. Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
SCIENCE

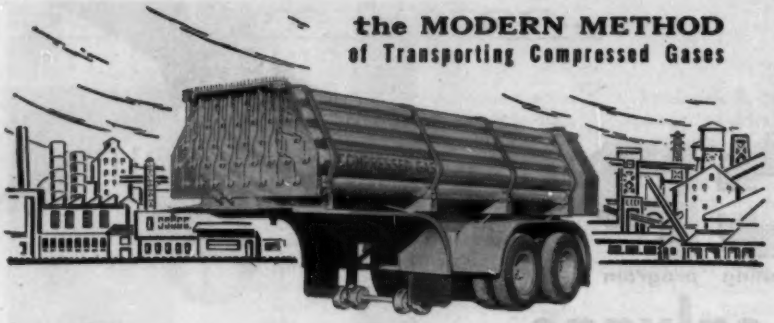
In our 50th year

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

Oakite ECP
your economy key

For more data on advertised products, use Readers' Service Cards, last page.



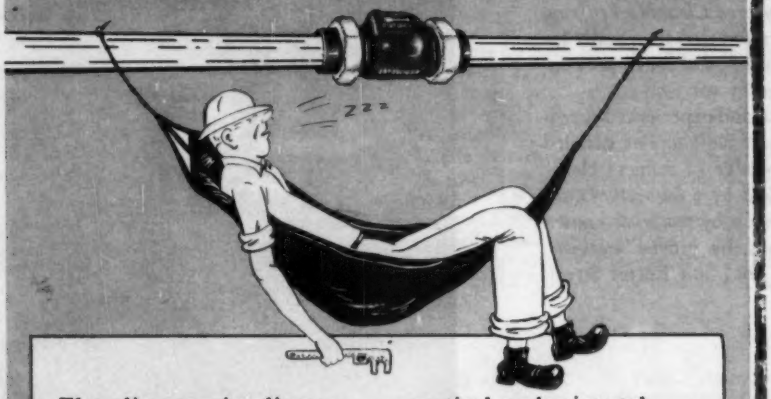
IECO gas supply TRAILERS tailored just for YOU

- MANIFOLD & CONTROLS — for YOUR Gas and Handling Requirements
- CAPACITY — to meet YOUR Requirements
- SAFETY — Cylinders, Safety Devices, Controls etc., All in accordance with ICC Requirements for YOUR Protection.
- CHASSIS — by leading Chassis Manufacturers with Service Branches throughout the United States for YOUR Convenience.

SEND YOUR INQUIRIES TODAY TO

INDEPENDENT ENGINEERING COMPANY, Inc.
Manufacturers of
CONSULTING IECO DESIGNING RESEARCH
CYLINDERS AND GAS PRODUCING EQUIPMENT
ACETYLENE · OXYGEN · NITROGEN · ARGON
O'FALLON 6, ILLINOIS

EASY LIVIN'
with Catawissa '502' Check Valves



Flow line or pipe line use . . . vertical or horizontal . . . no extra fittings for installing . . . full opening for flow of fluid or cleaning mechanism . . . easy to inspect, repair or replace parts . . . self cleaning . . . dependable . . . fully guaranteed.

WRITE FOR CATALOG 58
or ask for your copy at your favorite supply store

CATAWISSA VALVE & FITTINGS COMPANY
CATAWISSA · PENNSYLVANIA

Suppliers . . .

velopment, and in 1954 was named a director of Fuller Co. Talmey is a member of the American Physical Society, ACS, American Society of Heating, Refrigerating and Air Conditioning Engineers, and American Society for the Advancement of Science.

ESCAVATH CO., a new firm specializing in building industrial scale models, has opened offices at 4305 LaBranch, Houston. Partners in the company are **Albert Escamilla, Jr.,** formerly with Wyatt C. Hedrick Engineers and Tellepsen Petro-Chem; **Rene Horvath,** formerly with Hedrick and Southwestern Plastics Co., and **Charles Lange,** University of Houston graduate, formerly a draftsman. The firm plans to expand and move into new offices at 900 Yale St., Houston, sometime in August.

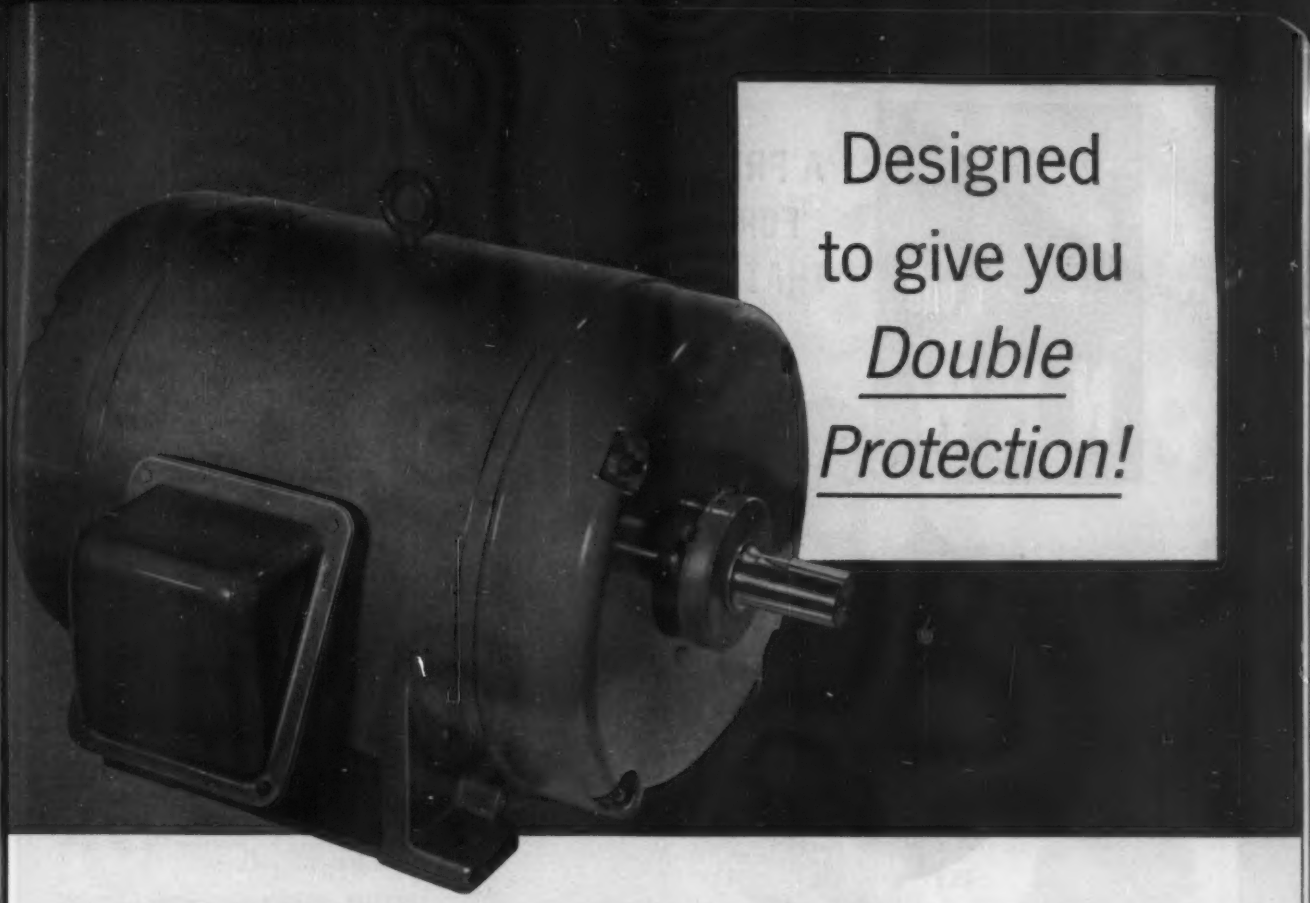
MIDWEST PIPING CO., INC., St. Louis, has purchased from the Sparton Corp., Jackson, Mich., the physical assets of two Sparton subsidiaries, Flori Pipe Co., St. Louis, and Houston Pipe & Steel, Inc., Houston. Carter described the purchase as an initial step in Midwest's plans to extend and broaden its nationwide operation.

H. K. PORTER CO.'s Refractories division has named **R. G. Vervaeke** manager at Pascagoula Works, and **Walter A. Tallon** geologist. Vervaeke was formerly general manager of Chemical Lime Co., Baker, Oregon. He was also general superintendent of Mines at Gladding-McBean & Co. Tallon will supervise the Refractories division's raw material exploration and procurement activities. Previously he was with the West Virginia Geological Survey.

CONSOLIDATED SYSTEMS CORP., a subsidiary of Consolidated Electrodynamics Corp., has established regional offices in Washington, D. C., Atlanta, Ga., and Monrovia, Calif. The three offices form the nucleus of a field engineering organization that will include additional offices throughout the nation by the end of the year.

BECKMAN INSTRUMENTS, INC.'s Scientific and Process Instruments division has named **Paul Ayers** service manager and **Elwood F. Blondfield** training manager, Fullerton, Calif. Former service manager for laboratory instrumentation, he will direct product service programs for both scientific and process instruments in his new post. Before joining Beckman in 1946, he was with Aluminum Co. of America.

BLACK, SIVALLS & BRYSON, INC.'s Newton D. Baker, director of employee and public relations, has been elected marketing vice president. He will participate in the review and analysis of marketing operations in all divisions, and assist division sales managers with sales training and sales planning programs. Baker will also handle all advertising, sales promotion and public relations activities, and serve



Designed to give you *Double Protection!*

WAGNER TYPE DP MOTORS

PROTECTED against corrosion...

PROTECTED against splashing liquids...

WM59-9

Wagner Type DP Motors provide *double protection* that means longer life—more versatility of application. Rugged cast iron frames and endplates are highly resistant to corrosion. Dripproof enclosures are so well designed that these motors can handle many applications that formerly required splashproof motors. These motors pack ample power into little space, are light in weight and are easy to maintain.

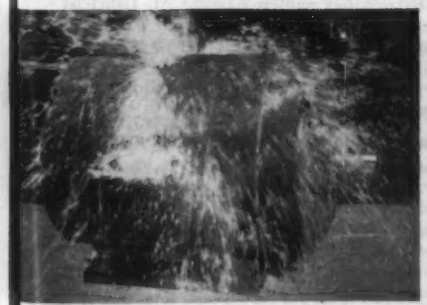
SLEEVE BEARING MODELS AVAILABLE. The entire line of ratings is available with ball bearing construction, or with steel-backed, babbitt-lined sleeve bearings of high load carrying capacity that provide quieter operation.

Let a Wagner Sales Engineer show you how these motors can be applied to your needs. Call the nearest branch office or write for Wagner Bulletin MU-223.

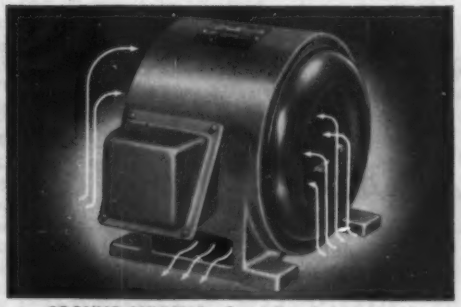
Branches and Distributors in All Principal Cities

Wagner Electric Corporation

6458 Plymouth Ave. • St. Louis 14, Missouri



DOUBLY PROTECTED—Air intakes and outlets are positioned to provide complete protection against dripping or splashing liquids. Rugged cast iron frames protect against rough handling and corrosion.



COOLING RUNNING—Specially designed baffles, which protect the stator windings, direct a cooling stream of air through the motor to effectively cool the motor—add to motor life.

CAN BE RE-LUBRICATED—Original factory lubrication will last for years in normal service—but grease plugs are provided to permit re-lubrication that adds years to motor life under severe conditions.

ONE OF THE GARLOCK 2,000 NEW

A PRESSURE SEAL FOR AGITATORS THAT WITHSTANDS 3000 PSI!

Garlock MECHANIPAK* Seals are installed on hundreds of successful high pressure agitation jobs assuring "no-leak" operation against extremely-reactive chemicals and gases at high temperatures . . . and where pressures go up to 3000 psi.

Compare them to others. Garlock MECHANIPAK Seals are completely self-contained in a single unit; this allows quick and easy installation onto shafts.

Garlock MECHANIPAK Seals are the perfect answer to increasing pressures of sealed-vessel agitation. Available for any size shafts; temperatures to 700° F and above. Find out more about Garlock Mechanical Seals from your local Garlock representative, or write

*Registered Trademark

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.
For Prompt Service, contact one of our 26 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Canadian Div.—The Garlock Packing Co. of Canada Ltd. • Plastics Div.—United States Gasket Co.

Suppliers . . .

in a staff capacity on employee relations. He joined BS&B in 1950 as assistant advertising manager, became advertising and sales promotion manager a year later, and was promoted to director of employee and public relations in 1958.

JONES & LAUGHLIN SUPPLY DIVISION will distribute products manufactured by Taylor Forge and Pipe Works, Chicago. Taylor has plants at Chicago; Gary, Ind.; Fontana, Calif.; Carnegie, Pa.; Houston; Paola, Kans., and Hamilton, Ont.

KLEMP INTERNATIONAL, a new division of Klemp Metal Grating Corp., has been established to handle Klemp's international-foreign trade. The new division will be in Chicago.

BECKMAN INSTRUMENT INC.'s Scientific and Process Instruments division has named **Robert L. Jackson** production manager, Fullerton, Calif. Formerly quality control manager for the division, he joined Beckman in 1947 after serving six years with the U. S. Army. He studied engineering at the University of Maryland.

BLAW-KNOX CO., Pittsburgh, has named **Ernest E. Swartswelter** director and vice chairman. He was chairman of The Aetna-Standard Engineering Co., recently acquired by Blaw-Knox.

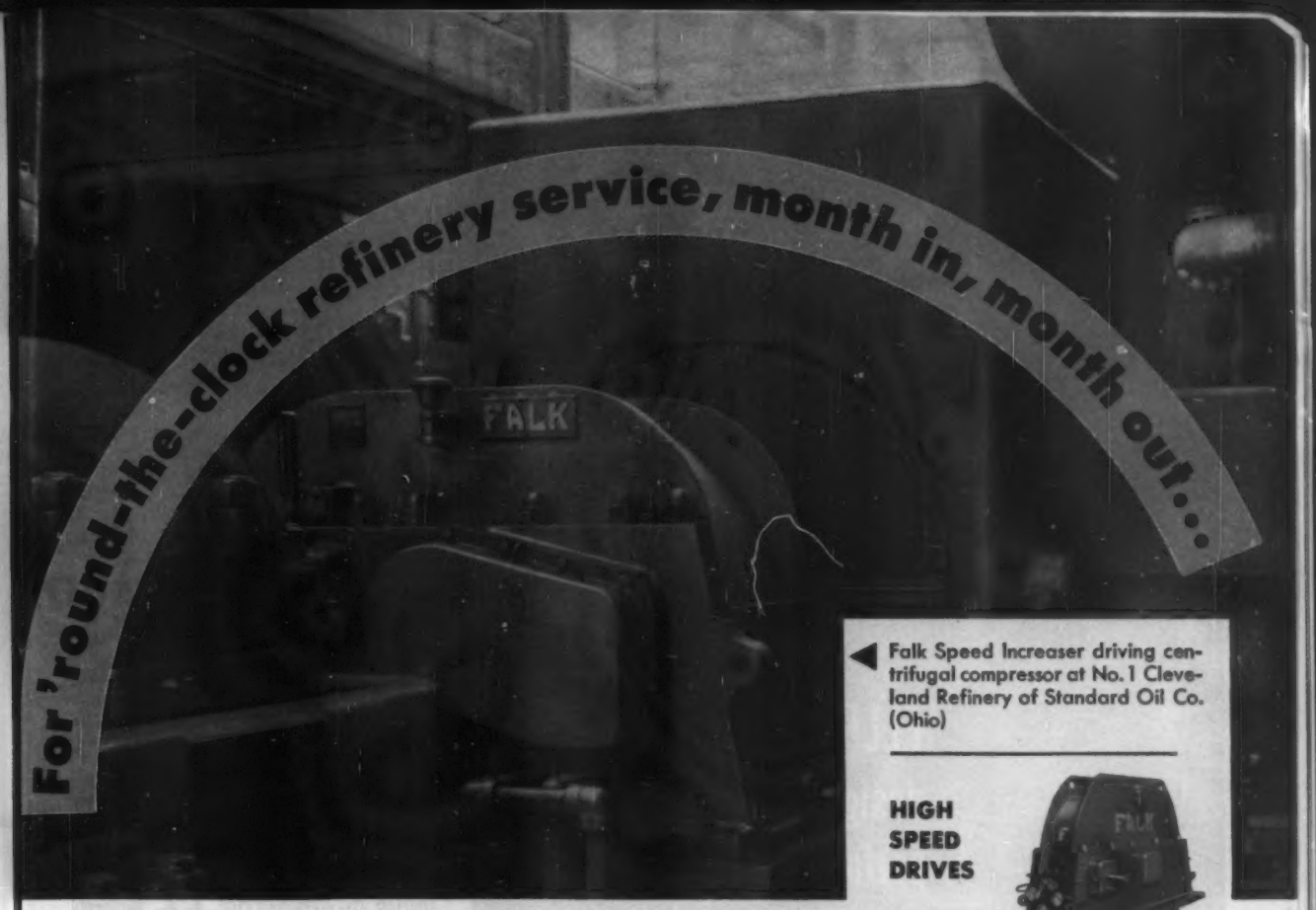
CHRYSLER CORP.'s Cycleweld Chemical Products division, Trenton, Mich., has just been formed from the former Cycleweld Cement Products division. **Sumner B. Twiss** has been named president. He joined the company's Engineering division in 1946 as a project engineer after receiving a B. S. degree in chemistry from Trinity College, Hartford, Conn., and a Ph. D. degree in chemistry from Johns Hopkins University.

B-I-F INDUSTRIES, INC., has named **William L. Sammons** general sales manager, Providence, R. I., assistant to the president during the past two years, he was with Carrier Corp. before joining B-I-F.

SELAS CORP. OF AMERICA's Fluid Processing Department, Dresher, Pa., has named **Clifford T. Stanhope** sales coordinator. He joined Selas from Petro-Chem Development Co., New York, where he was assistant vice president in charge of engineering.

CHEMETRON CORP.'s Chemical Products Division has named **Lansing M. Hinrichs** assistant to the president. He had been in charge of legal and patent activities for some of the company's Louisville operations. Hinrichs will also continue as patent counsel.

BECKMAN INSTRUMENTS, INC.'s Scientific and Process Instruments Division, Fullerton, Calif., has named **Harry H. Bauer** and **James E. Tebay** product line managers. Bauer will direct product planning and application of industrial gas chromatographs, flow colorimeters, oxygen anlyzers, and related instrumentation. Tebay will be responsible for process in-



◀ Falk Speed Increaser driving centrifugal compressor at No. 1 Cleveland Refinery of Standard Oil Co. (Ohio)

FALK offers a complete line of standard high speed and semi-high speed drives

type P Ratios—from 2.5:1 to 12.0:1.
Horsepower—up to 2000 hp per 1000 rpm of high speed shaft.
Maximum speed of high speed shaft: 10,000 rpm.

type Q Ratios—from 1.15:1 to 9.5:1.
Horsepower—up to 1800 hp per 1000 rpm of high speed shaft.
Maximum speed of high speed shaft: 10,000 rpm.

type H Ratios—from 2.22:1 to 9.89:1.
Horsepower: up to 1100 hp.
Maximum speed of high speed shaft: up to 3600 rpm.

type S Ratios—from 1.49:1 to 25.4:1.
Horsepower—up to 224 hp.
Maximum speed of high speed shaft: 4500 rpm.

SPECIAL DRIVES...to any required speed and horsepower.

• • • • •

Designed and produced by the Falk engineers who pioneered the ultra-high speed gear units for aviation turbo engine test facilities, Falk standard high speed drives are widely used in refineries throughout the country. Our technicians will be glad to work with your engineers or with your equipment suppliers to select and produce drives precisely suited to your operation.

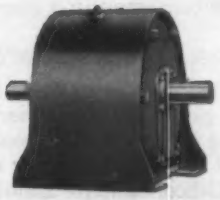
FALK is a Registered Trade Mark.

HIGH SPEED DRIVES

type P

type Q

SEMI HIGH SPEED DRIVES



type H

type S

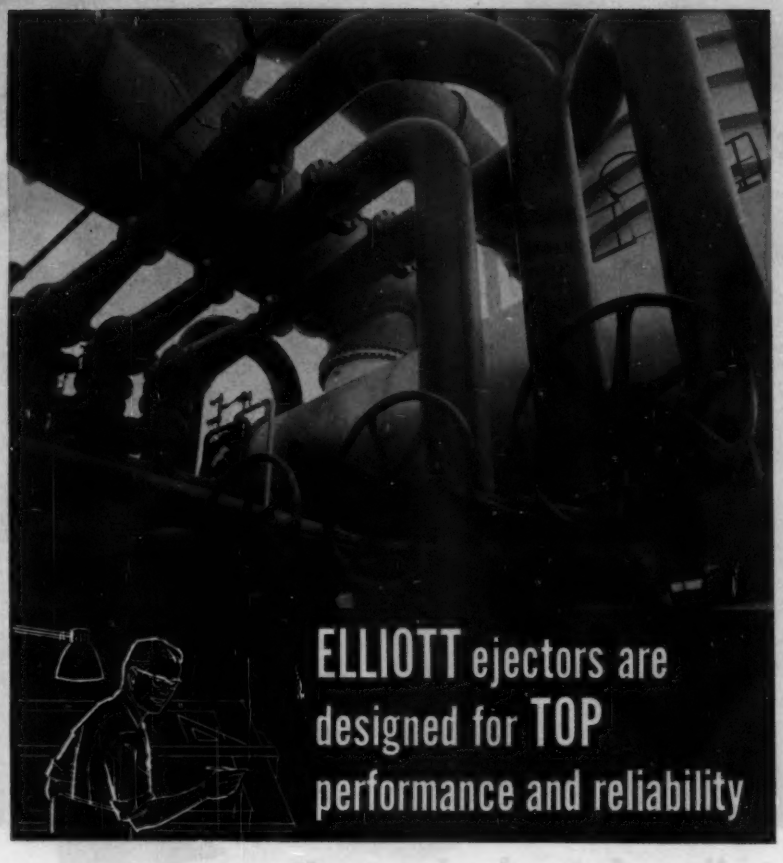
THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives in Most Principal Cities

FALK

...a good name in industry



. . . engineered and built to meet your requirements

An unusual example of Elliott's engineering experience in designing and building steam jet ejectors and auxiliary equipment for producing vacuum is seen above. This photo shows the three first-stage ejectors of an Elliott triple element two-stage unit which serves a residuum stripper in a California oil refinery.

The vapor load from this vacuum flash unit adds up to approximately 57,000 lb per hr of steam, condensable hydrocarbon vapor and noncondensable gas. To handle this load efficiently and economically requires maintaining approximately 2 in. Hg absolute pressure *continuously*. Two Elliott 11,000-sq ft surface condensers are used, arranged in parallel, and the Elliott triple, two-stage ejector which serves these condensers is discharged to an intercondenser and an after-condenser combined in a common shell.

wide range of single-stage and multistage types

of Elliott steam jet ejectors is available for maintaining low absolute pressures in refineries, chemical plants and other processing industries. For complete data or engineering assistance, call the Elliott ejector specialist at your nearby Elliott District Office, or write Elliott Company, Jeannette, Pa.

ELLIOTT Company

68-1

Suppliers . . .

frared gas analyzers, acidity-alkalinity meters, and other instrumentation for industrial process control.

TYSON SMITH CO. has named **Lester Farley** sales engineer for San Antonio, Victoria, and surrounding areas. Previously, he was with Halliburton Oilwell Cementing Co., Gulf Coast Machinery and Supply Co., and Rolo Manufacturing Co.

WESTINGHOUSE ELECTRIC CORP. recently held a two-day new-product seminar for its Gearing Division consulting and application engineers. Attended by engineers from all seven sales districts in the United States, the meeting was conducted by **A. S. Davis,** sales manager, gearing products. It was held at the division's Nuttall Works, Pittsburgh.

HARBISON-WALKER REFRACTORIES CO. has opened its new $2-million Garber Research Center in West Mifflin Township, Pittsburgh. The center was named in honor of **Earl A. Garber,** Harbison-Walker's president, under whose administration much of the company's expansion has taken place.

PANELLIT SERVICE CORP., Skokie, Ill., has named **Marvin B. Lorig** vice president and general manager. He has been with the parent firm, Panellit, Inc., since 1947 and as a vice president since 1952.

UNITED OILWELL SERVICE, S. A., formerly a Dowell subsidiary in Venezuela, has transferred its assets and business to the Dowell Division, The Dow Chemical International, Ltd., S. A. No change in operations is contemplated under the Venezuelan corporation.

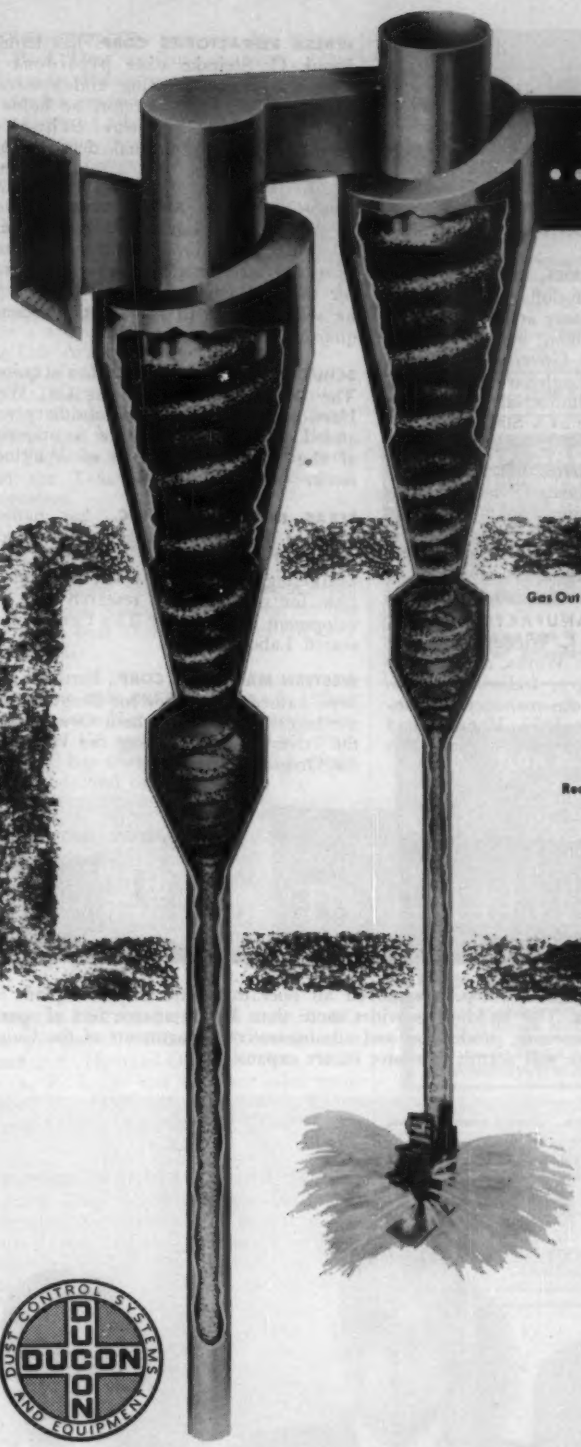
PFAUDLER PERMUTIT INC. has created an International Division and named **George C. Calvert** director and vice president. The division will handle administration, coordination and control of plans abroad, plus export sales from domestic plants.

PIPING PRODUCTS, INC., Moorestown, N. J., has been appointed a pipe-products distributor for Reynolds Metals Co. Piping Products serves a 50-mile trading area in the Delaware valley from Trenton, N. J., to Wilmington, Del.

CLARK MANUFACTURING CO. has appointed **W. J. Manthey** vice president. Having spent more than 13 years in advertising, marketing and sales promotional activities, he was previously with Curtiss-Wright Corp., Marquette Division, in charge of advertising and sales promotion.

LIBRASCOPE, INC., has broken ground for a major addition to its Glendale headquarters. The new building will have 85,000 square feet of space. Approximately 800 employes will occupy the building when completed in November.

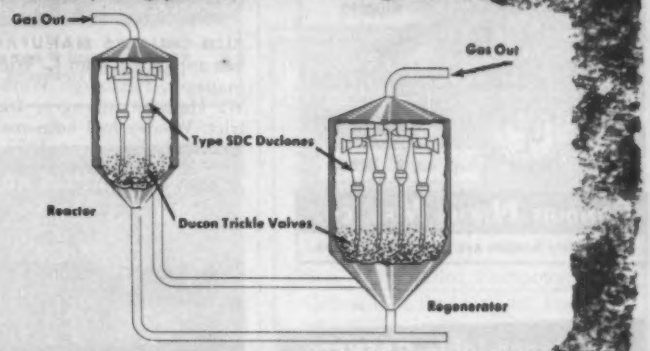
MIDWEST PIPING CO., INC., St. Louis, has named as vice president (administrative) **Norman B. Champ, Jr.,** former assistant



. . . in catalyst recovery

Type *SDC* DUCLONES assure

- ***HIGH EFFICIENCY***
- ***LOW PRESSURE LOSS***
- ***LONG SERVICE LIFE***



Ducon Type SDC Catalyst Recovery Duclones have earned the approval of the world's leading refineries for their effectiveness in catalyst recovery and other fluid bed processes.

The exceptional performance of Type SDC Duclones is the result of 6 unique design features:

1. Helical Inlet to reduce turbulence
2. Steep Cone for improved dust separation
3. Dust Trap to reduce entrainment
4. Scroll Outlet to provide low resistance, tangential gas exit
5. Small Diameter for high efficiency
6. Vortex Shield to reduce entrainment of dust in the upward flowing gas stream.

For additional information on Type SDC Duclones send for Bulletin C-2058.

DUCON — DUST CONTROL SYSTEMS AND EQUIPMENT

the name in DUst CONtrol

THE **Ducon** COMPANY INC.

147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK

Canadian Branch:
THE DUCON COMPANY of CANADA, Ltd.,
1131 Pettit St., BURLINGTON, ONTARIO

CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

ALUMINUM

RIGID *Conduit*

PIPE FITTINGS

CONDUIT NIPPLE MFG. CO.

1455 SPRING GARDEN AVE. PITTSBURGH 12, PA.

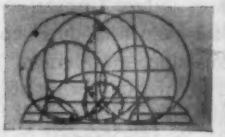
For Dependable GASKETS

Specify CHICAGO-WILCOX

RING GASKETS

For ring-type flanged joints in high pressure lines. Made of soft iron, standard steel alloys or any non-ferrous metal to any desired cross section. Ask for Bulletin 563.

HEAT EXCHANGER GASKETS



Made in any size or shape needed in double-jacket type. Also cut from solid metal or sheet packing. Ask for Bulletin 564.

CORRUGATED METAL GASKETS

Plain or jacketed type. Made of ingot iron, aluminum, stainless steel, copper, brass, nickel and monel in all sizes and shapes. Ask for Bulletin 565.

Prompt Deliveries

7719 S. Avalon
Chicago 19, Ill.

CHICAGO-WILCOX MFG. CO.

Suppliers . . .

to the president and general manager of operations. **E. B. Stolle,** former manager of the Pacific Division, was named vice president, Pacific Division, Los Angeles. **T. R. Taylor, Jr.,** former manager of the Eastern Division, was appointed vice president, Eastern Division, Clifton, N. J.

ENGELHARD INDUSTRIES, INC. has dedicated a new million-dollar research and development laboratory at Newark, N. J. Speaking before about 300 persons at outdoor ceremonies, **Governor Robert B. Meyner** stressed Englehard's contributions to "areas of industrial opportunity in which our future as a State rests."

BECKMAN INSTRUMENTS, INC.'s Scientific and Process Instruments Division, Fullerton, Calif., has named **John V. Spray** quality control chief. A former inspection supervisor, he will direct all inspection and quality control functions.

ALLIS-CHALMERS MANUFACTURING CO. has appointed **John L. Wiedey** marketing manager, Pittsburgh Works, and **George W. Hanafee** manager, Indianapolis district. Wiedey had been manager, Indianapolis district, since 1957. Hanafee had been a sales representative, Indianapolis district, since 1952.

WALSH REFRACTORIES CORP. has named **Frank C. Steimke** vice president in charge of manufacturing and research. Previously research director, he holds a B.S. degree from Missouri School of Mines and a professional degree from U.C.L.A.

UNION ASBESTOS AND RUBBER CO. has named **E. W. Vizard** Midwest regional sales manager, Fibrous Products Division. Formerly sales representative in Chicago for the Chicago and Kansas City areas, he will transfer to the division's headquarters, Bloomington, Ill.

SCHUTTE AND KOERTING CO. has acquired The Whitlock Manufacturing Co., West Hartford, Conn. The new subsidiary was added through purchase of a majority of the outstanding shares of Whitlock stock.

TEXAS INSTRUMENTS, INC., has named **Richard C. Wood** marketing manager, advanced technologies, Central Staff Marketing Division. He will be responsible for marketing of research and development activities by TI's Central Research Laboratory.

WESTERN MACHINERY CORP., Portland, has been named distributor for Borg-Warner mechanical seals throughout Oregon and the "river counties" along the Washington-Oregon border.

Technical Measurement Corp. has moved all operations into this new plant in North Haven, Conn. The building provides more than 11,000 square feet of space and houses all engineering, production and administrative departments of the Company. The 3-acre site will permit extensive future expansion.

The Petroleum Electric Power Association elected new officers for 1959-60 term at its 31st Annual Meeting recently. The incoming president is D. S. Coffman, (center) Texas Power & Light Co., Dallas.; vice president is W. M. Larkin, (left) Gulf States Utilities Co., Lake Charles; secretary-treasurer is B. F. Thompson, (right) Public Service Co., Tulsa. Also elected were 12 new directors.

CROUSE-HINDS CO., Syracuse, has named **H. Paul Dees** regional manager, Gulf Division, Houston. Under his supervision are Corpus Christi, San Antonio, Austin, Beaumont, Longview, Lake Charles, and Texarkana.

Dees

Dees has been with Crouse-Hinds since 1957. A graduate of The University of Texas, he previously was a specialist with the U.S. Army Signal Corps, Washington, D. C. Dees is on the program committee of the Petroleum Electric Supply Association, and is a member of AIEE, Houston Engineering and Scientific Society, and the Texas Society of Professional Engineers.

MARSH INSTRUMENT CO., Skokie, Ill., has named **Bernhard Willach** vice president of engineering. Holder of an engineering degree from Cologne University, he has spent the past 17 years as chief engineer for Marsh.

NATIONAL CAN CORP. has named **Arthur R. Jorgensen** North Atlantic district sales manager. He came to National 29 years ago, and has worked in purchasing, credit and inside and outside sales.

ALLOY STEEL PRODUCTS CO. has named **Richard E. Boller, Jr.,** general sales manager, Linden, N. J. Previously Northeast regional sales manager, he will supervise the inside and outside sales organizations, advertising and sales promotion, market research and new product development.

GENERAL CONTROLS CO., Glendale, Calif., has appointed **William R. Kennedy** sales manager, Hammel-Dahl Division, Warwick, R. I. He was assistant sales manager, Hammel-Dahl Co., before it became a division of General Controls.

ROCKWELL MANUFACTURING CO. has named **Paul A. Wick** assistant to the president and assistant secretary. He joined the Legal Department in 1946, was named assistant secretary in 1948, and has been assistant to the president since 1951.

AMERICAN METER CO., INC., has named **Albert L. Weldy** sales representative for the Birmingham sales district, with headquarters in Pompano Beach, Fla. Weldy has 19 years' experience with American Meter at its Philadelphia factory, and recently completed a six month sales training course at Erie, Pa.

THE SAN JACINTO RUBBER CORP. celebrated its first year of operation on June 16. The firm, which maintains manufacturing facilities at 7306 Gonzales St., Houston, handles custom rubber work such as molding, extruding, and lathe cutting.

Petroleum Refiner New Classified Rates

RATES: **Regular Classified** (undisplayed) set in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

* * * * * * * * * * * * * * * * *

FOR SALE

Specify SAUEREISEN
ACIDPROOF CEMENTS—COMPOUNDS
FOR
Tanks, Sewers, Stacks, Floors
Technical cements for all purposes.
Send sketches or samples
Sauereisen Cements Company · Pittsburgh 15, Penna

When you see a large chimney think of Sauereisen Cements.

FLOW INDICATORS
All sizes up to 8"
SEND FOR CATALOG
ERNST
Water Column & Gage Co.
LIVINGSTON, N. J.
CYLINDER
DOUBLE WINDOW

NEW WATERLESS DECALS
Permanent type tough "Vinyl" applied in seconds without water. Saves labor; no curing in storage. MADE TO YOUR SPECIFICATIONS...lettering, numbers, your trademark. Send now for FREE SAMPLES and estimate.
SCREEN PROCESS PRINTING CO., P.O. Box 948, Wichita 1, Kansas

REFINERY INSPECTION GAUGES
JOHN J. BECKER CO.
BRADFORD, PA.

WANTED

SALES OPPORTUNITY

■ $200.00 profit per average direct sale with a well known natl. adv. Pipe Tool. A MUST for every Contractor and Industry using pipe or conduit. No technical knowledge required. Shipped on trial to help get orders. Leads furnished. Write background, reference, etc., to box number 318-R, PETROLEUM REFINER, Houston, Texas.

HELP WANTED

INSTRUMENT SALES ENGINEER WANTED

Prefer Chemical Engineers with petroleum and process experience. Openings in St. Louis and El Paso. Mail reply to W. Messner, The Bristol Company, 434 Cotton Belt Building, St. Louis 2, Missouri.

CHEMIST OR ENGINEER

Having knowledge of Petroleum Refining and proved ability to write. Will write monthly digest of new developments in fuels, lubricants, petrochemicals, etc., and the proceses used to make them. Other technical writing for wide circulation. Also editing of such material. Creative, top-level job. Send resume to:

Personnel Manager
ETHYL CORPORATION
1600 West Eight Mile Road
Ferndale 20, Michigan

OIL REFINERY SUPERVISORS AND ENGINEERS

Former Maritimers and others desiring supervisory or engineering positions in new 40,000 BPD Oil Refinery in the Maritimes, please write R. C. Felt, Refinery Manager, Irving Refining Limited, P. O. Box 1260, Saint John, New Brunswick, Canada. Inquiries will be treated in confidence.

For more data on advertised products, use Readers' Service Cards, last page.

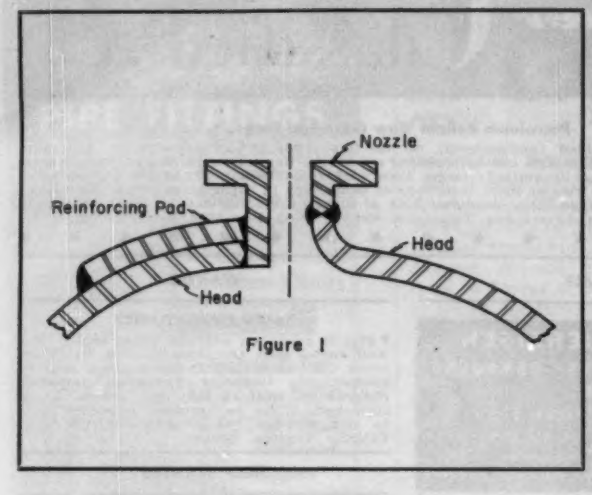
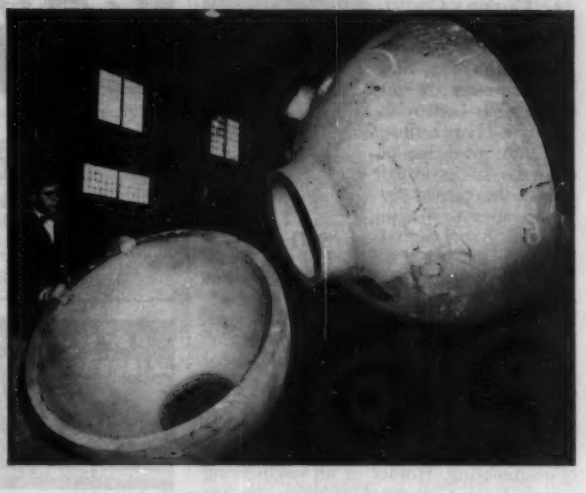


Figure 1



Flued Nozzles Improve Vessel Design

This unusual pressure vessel head features smooth contours, reduced stress and no weld cracking

Something new in pressure vessel head design has added to the desulfurizer-reformer installation at Shell Oil Co.'s Houston refinery. In place of conventional welded-in nozzles with reinforcing pads, Shell uses *flued* openings in heavy-gage steel heads.

In traditional practice, a head shape opening is made by cutting a circle in the head, welding a nozzle in place, and reinforcing it by welding a pad around the nozzle (Figure 1, left).

Flued Head. After considerable experimentation, Shell developed a flued head made of stainless-clad steel plate 2⅝ inches (minimum) thick (Figure 1, right). The clad plate is Type 410 solid stainless on Type A-204 carbon-molybdenum back steel. This head is 78 inches in diameter with two flued openings, one 18 inches in diameter, and the other 5⅜ inches in diameter.

New Approach. It was reasoned that flued openings would minimize sharp corners and metal grain discontinuities by virtue of smoother contours and would provide an improved head opening design.

A new reformer was also installed with a flued head made of chrome-molybdenum plate three inches thick (A-387 Grade B). Measuring 60 inches in diameter (O.D.), this head has two flued openings, 5⅜ inches and 18 inches in diameter.

No Weld Cracking. One-piece construction of flued heads, now proved in service, provides smooth contours, reduces stress concentrations and eliminates the weld cracking that leads to possible failure in conventional welded-in contruction subjected to cyclic or thermal shock service. Hot forming of the flued openings gives the components improved metallic grain flow. Lukens Steel Co.

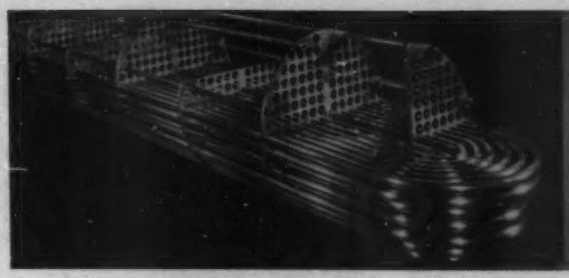
Circle E1 green card, last page

Tape Seals Pipe Threads Eliminates Dope Solutions

A chemically-inert tape which seals and permanently lubricates pipe joints, has just been announced.

Called "Scotch" brand Pipe Sealant Tape, No. 547, this unfused film tape, available in three and four-mil calipers, can be applied in seconds and conforms to all types of pipe threads and fittings.

Made with "Teflon," it can withstand processing temperatures from the liquid-oxygen range through that



CONDENSER AND HEAT EXCHANGER CLINIC

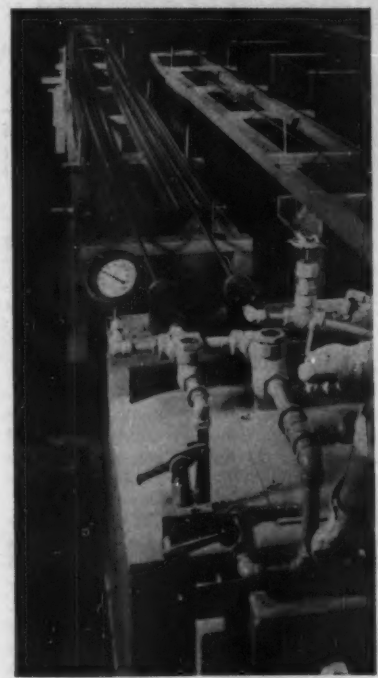
Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, New York

New controls and services meet increasingly critical requirements in heat-transfer units

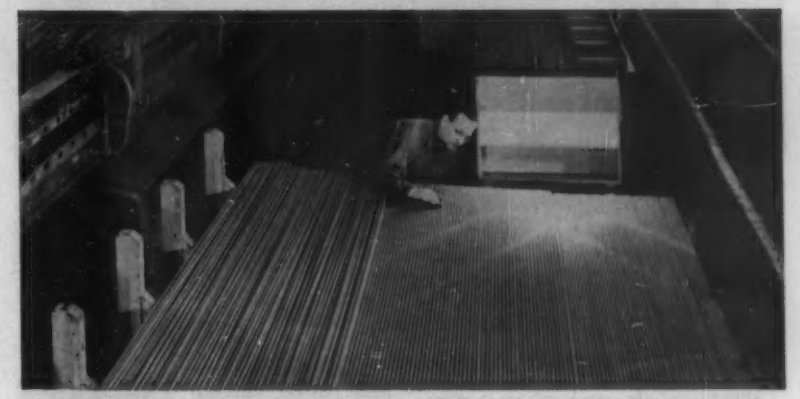
As steam cycles in turbines become more complex—and operating temperatures and pressures rise—the job of the heat-transfer equipment becomes increasingly critical. Nuclear energy plants place tremendous emphasis on continuity of service for even conventional components like condensers. And in many processing plants the cost of shutdowns may range from exorbitant to disastrous.

Assurance that tubes will meet service requirements becomes increasingly important. And The American Brass Company has augmented its normal quality controls with tests and services to help makers of heat transfer equipment prevent possible trouble before it starts.

Electronic inspection. All tubes are inspected visually one at a time, both internally and externally. However, where greater assurance is required, the tubes—in straight lengths up to 100′—can be inspected electronically by eddy-current equipment.



All U-bend tubes are tested hydrostatically at ASME Code pressures—or higher, if necessary.



All tubes are inspected visually one at a time, both externally and internally.

When required, tubes are inspected by eddy-current equipment, located at the tube straightener.

Hydrostatic testing. As most U-bend tubes are used in applications involving high temperatures and pressures, all of these tubes are tested hydrostatically—after bending—at ASTM Specification pressures. They can, however, be tested at ASME Code pressures, up to 6000 psi, on request, if the tube size is such that it will withstand the pressure.

Relieving stresses. All U-bend tubes, other than copper, are annealed at the bend area after bending, to eliminate the hazard of stress-corrosion cracking which might occur in service due to stresses that may exist as a result of the bending.

Duplex tubes are widely used in chemical plants and petroleum refineries to meet diverse combinations of corrosive action and/or pressure and temperature. Recently designers have selected them for use in air-removal sections of electric-power-plant condensers where corrosion is very severe.

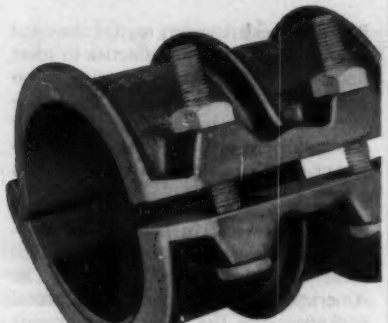
Broadest service. In helping manufacturers and users of heat-transfer equipment meet day-to-day problems, The American Brass Company has a broad background in the latest developments in heat-transfer equipment's expanding role. And with new mill equipment now in place, it offers the broadest service available in tubes for heat-transfer equipment. For technical assistance in special problems, write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5008 Rev.

ANACONDA®

TUBES AND PLATES FOR
CONDENSERS and HEAT EXCHANGERS
Made by
THE AMERICAN BRASS COMPANY

SKINNER-SEAL
PIPE JOINT CLAMP STOPS LEAKS
at joint where pipe is screwed into fitting

SKINNER-SEAL
PIPE JOINT CLAMP stops leaks at joints where pipe is screwed into fitting. Any temperature—any pressure up to 2,000 pounds. Saves the cost of tearing out and renewing leaky fittings. Prevents shutdowns. In stock at most oil supply stores.



SKINNER-SEAL
EMERGENCY PIPE CLAMPS for safe, sure, lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C.I. pipe. Stocked by practically all oil supply stores.

Complete line of Repair Clamps. Send for Catalog 54!

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

Equipment . . .

of super-heated steam. It is not affected by oil traces or other lubricants in the steam line.

Although non-adhesive, the tape is sufficiently cohesive to stick to its own glossy surface.

The tape's easy application eliminates the need for brushing messy dope solutions on pipe fittings. It can be applied by one person, and a single wrapping affords full protection. Excess tape can be torn off easily.

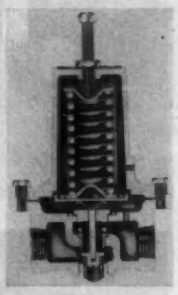
The tape's anti-sticking characteristics lubricate joints so they can be loosened and detached years after the threads are taped.

This white, pliable tape is available in convenient 36-yard rolls in ¼ to 8 inch widths. Minnesota Mining & Mfg. Co.

Circle E2 green card, last page

PRV Provides Accurate Control Of Steam Pressure

A new direct-operated reducing valve, for both steam and air service, has just been developed.



Designated No. 17-1, this new regulating valve provides accurate control of steam pressures for a wide variety of plant applications. It features accurately sized and located ports to minimize fall off, isolated diaphragm chamber for maximum stability, large body passages, and lapped seating surfaces for tight shutoff. A variation, No. 17-22, is made with a special soft seat for air service.

This regulating valve is light in weight, compact, easy to install and maintain, and is available in a selection of reduced pressure ranges, adjustable over a suitably wide span.

Specifications of the No. 17-1 include sizes of ½ inch, ¾ inch and 1 inch in iron construction; and reduced pressure ranges of 2-12; 8-50; and 25-150 psi. Mason-Neilan Co.

Circle E3 green card, last page

Evaporation Losses Cut By 90 Percent Says Bulletin

A new 7-page technical bulletin on the use of Colfoam Microballoons in reducing evaporation losses in crude oil tanks has just been released.

Microballoons (Trade Mark of Std. Oil Co., Ohio) are tiny, hollow, plastic spheres filled with inert gas, which reduce evaporation by floating on top of the stored crude oil as a continuous thick layer of foam. This stable foam layer acts as a blanket or floating roof, forming a continuous vapor barrier and resealing itself after passing over obstructions. Colton Chemical Co.

Circle E4 green card, last page

Hydrogenation Catalyst Information In Bulletin

A new information bulletin on G-43 platinum-base hydrogenation catalyst is now available.

Applications described include promoting reactions of oxygen and oxides of nitrogen with hydrogen, carbon monoxide, methane, propane or other hydrocarbons.

Information is also provided on previous uses of the G-43 catalyst in commercial applications including power recovery from nitric-acid-plant tail gas, and in reduction of oxides of nitrogen content in nitric acid plants to levels below those required by air pollution control agencies.

Operating and physical characteristics of the G-43 and catalyst life and payout periods in typical applications are also discussed. Girdler Catalysts.

Circle E5 green card, last page

Crude Gravity Automatically Recorded on Instrument

A Chicago firm has been licensed by Sinclair Research Laboratories, Inc., to manufacture and sell a new petroleum instrument, the Sinclair-Cenco Controlling and Recording Gravitometer. It automatically measures and records gravity in crude oil. The device has a very fast response and extremely sensitive ($\pm$ 0.1° API) continuous-gravity recorder. Automatic blending of two different crude oils to a constant outgoing gravity can be accomplished with highest precision and stability. Central Scientific Co.

Circle E6 green card, last page

Insulation Cuts Cracker Thin Without Crumbling

Careytemp, a completely new pipe and block insulation for all temperatures up to 1,600° F, has just been introduced.

Composed of expanded silica with a specially developed binder, and reinforced with inorganic fibre, the new product features exceptional water resistance, light weight at no sacrifice of strength, and ease in cutting without crumbling. It requires no special tools and saves application time and costs.

Carytemp can be cut cracker-thin without crumbling. Due to precision molding process, edges are neat and square providing tight joints. The Philip Carey Mfg. Co.

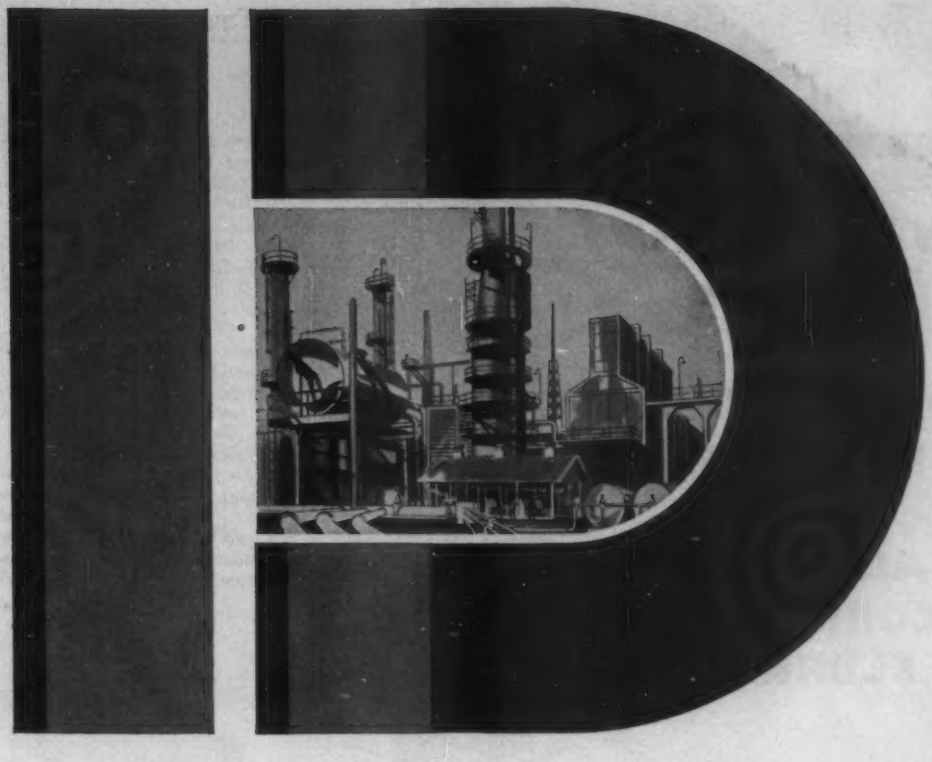
Circle E7 green card, last page

Antioxidants Stabilize Fuels And Lubricants

Fuels and lubricants become more stable, durable and effective when small amounts of the antioxidants are added to them. Similar improvements take place in articles made of rubber or plastics.

Ethyl Corp. reports that eight antioxidants discovered and developed in its laboratories are available in commercial or development quantities. Scores of additional agents are in experimental stages.

All of the new agents are based on the ortho-alkylation process, which is responsible for the first commercial introduction of many derivatives of phenol and aniline. The parent compound for most of



LP&L proves feasibility of computer process control--buys second computer system

Here's important news for everyone interested in automatic process control. After one year's operational experience with a Daystrom computer operating on-line at its Sterlington Steam Electric Station, Louisiana Power & Light Company has purchased another Daystrom system. This new digital computer will provide completely automatic control for LP&L's new 230,000 kw Little Gypsy Station. The techniques inherent in the LP&L installations are directly applicable to the requirements of the process industries.

The original Sterlington installation, delivered over a year ago, came about through the combined engineering efforts of Louisiana Power & Light Company, Ebasco Services, Inc., design and consulting engineers for LP&L, and Daystrom Systems.

The Sterlington computer system performance has demonstrated for the first time the reliability and utility essential to the stringent requirements of overall control responsibility. This field operating experience permits Daystrom to guarantee system operational availability of more than 99%. The uncompromising criterion of design which makes this performance possible dictates the complete elimination of vacuum tubes and moving parts.

The Little Gypsy computer system will perform the following functions: (1) Control sequentially the 800 or more steps necessary for plant start-up and shut-down, continuously checking the overall progress of the operation; (2) Monitor at the rate of ten times per second the hundreds of electrical signals signifying plant operating conditions and safety; (3) Instantly recognize abnormal conditions and take appropriate corrective action automatically; (4) Control combustion, feed water and steam temperature for best efficiency.

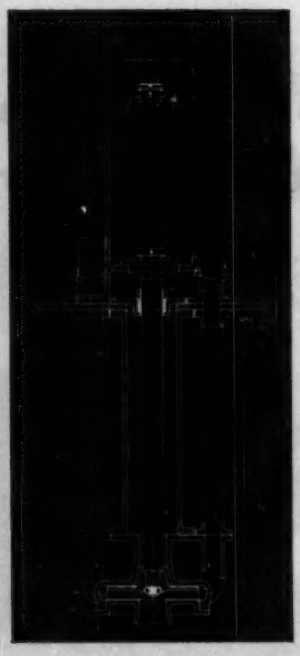
A substantial number of these systems have already been purchased for performance data reduction and automatic control. The availability of these new techniques and associated equipment to the process industries warrants your careful study. For conference arrangements, write or telephone Daystrom Systems, Dept. A-113, Miramar Road, La Jolla, California. GLencourt 4-0421.

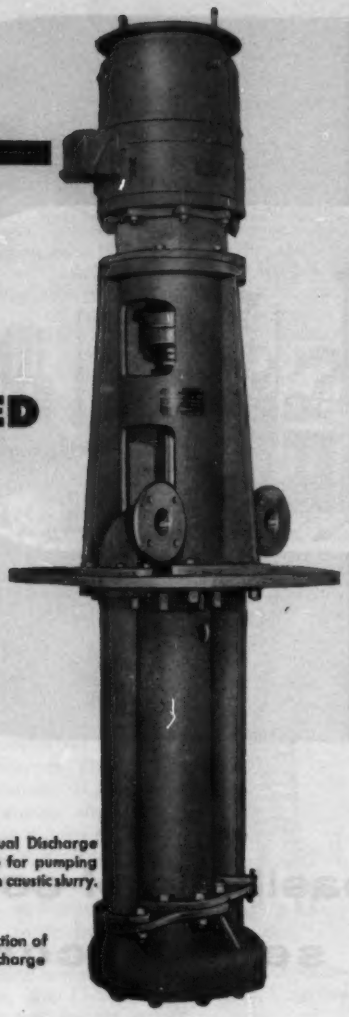
INPUT CONSOLE—STERLINGTON COMPUTER

DAYSTROM SYSTEMS
DIVISION OF DAYSTROM, INC.
Reliable computer control systems

For more data on advertised products, use Readers' Service Cards, last page.

VERTICAL PUMPS WITH NO SUBMERGED BEARINGS FOR PUMPING ABRASIVE CORROSIVE SLURRIES





2" Dual Discharge Pump for pumping molten caustic slurry.

Cross section of Dual Discharge Pump.

This rugged type of service calls for advanced design: — extra heavy shaft, double-ported casing to equalize the side thrust of the impeller, and tough abrasion-corrosion resistant alloys. The dual discharge pump illustrated here incorporates these features and dispenses with bearings or packing below the cover plate where they would be in contact with the liquid.

Difficult pumping problems, particularly in the process industries, have been our specialty for ninety-one years. Perhaps we can be of help to you. Write us — no obligation.

LAWRENCE PUMPS INC.

Write for Bulletin 203-6 for complete summary of acid and chemical pump data.

371 MARKET STREET, LAWRENCE, MASS.

Equipment . . .

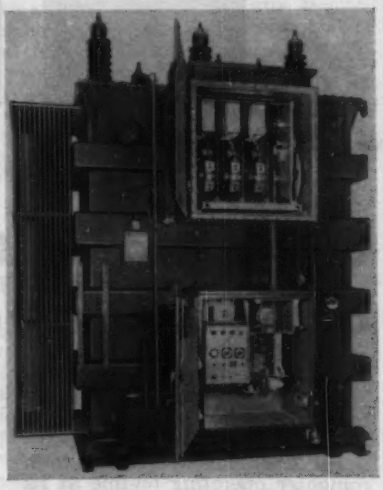
the antioxidants is known chemically as 2, 6 di-tert butylphenol.

Two of the ortho-alkylation additives are designed primarily to extend the storage life of high-octane gasolines and jet fuels. Gum formation and decomposition are reduced considerably. By increasing engine cleanliness, carburetor and intake valve problems are checks. The compounds also help extend the useful life of industrial oils for circulating systems and steam turbines.

Other antioxidants are for addition to automotive and aviation engine oils and automatic transmission fluids. Scuffing-type piston wear is cut down and automatic transmission parts last longer.

For purposes other than in fuels and lubricants, antioxidants give advantageous properties to products made of rubber and plastics. Preliminary findings in evaluation tests at commercial laboratories and among principal rubber and plastics manufacturers are "most promising," the company reports. Ethyl Corp.

Circle E8 green card, last page

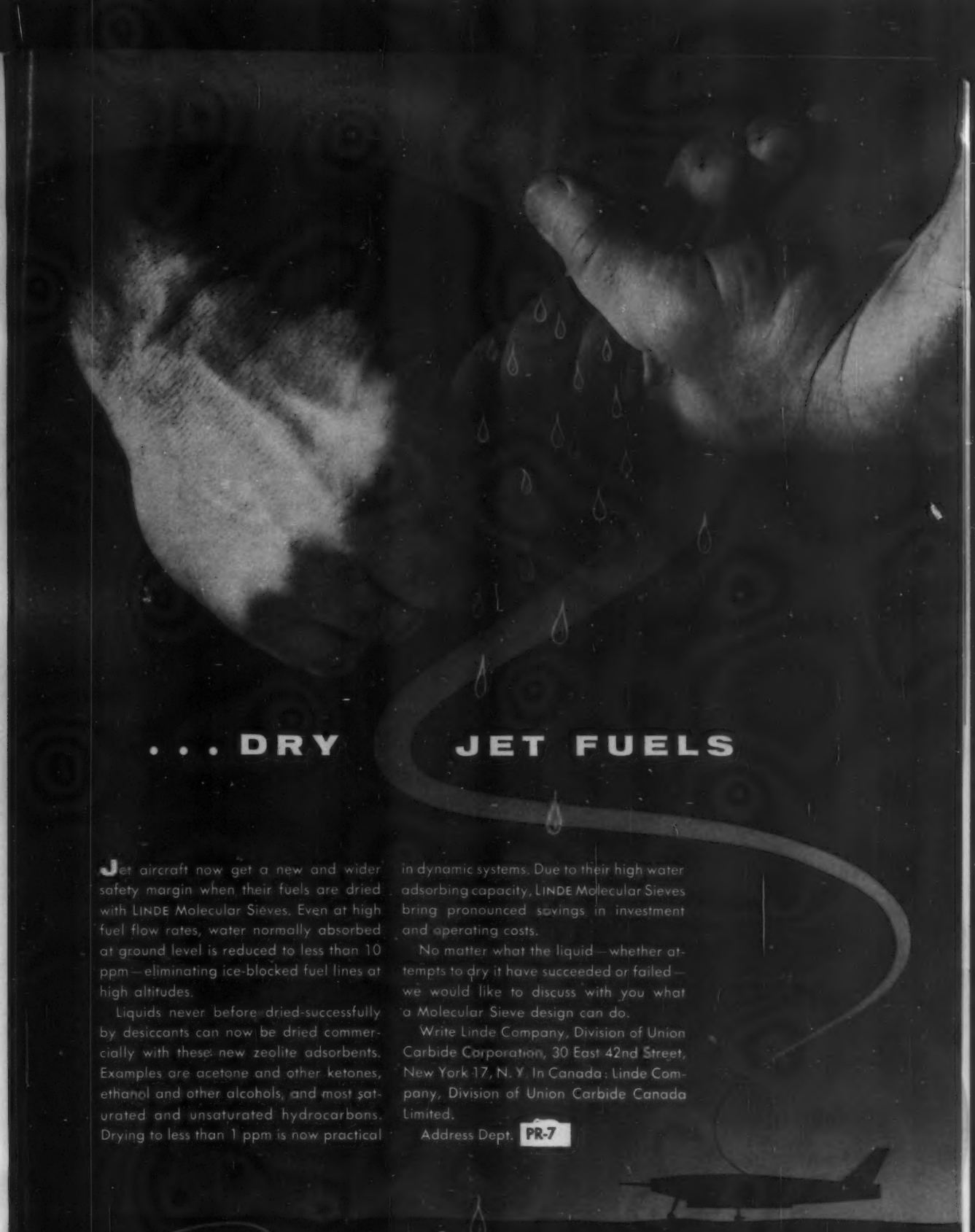


Magnetic Amplifier Control Featured In Transformers

Three-phase, load-tap-changing power transformers, with plus or minus 10 percent voltage regulation in ⅝ percent steps, use magnetic amplifiers in the voltage sensing circuit to initiate a tap change when required. Their use results in accuracy of control, since the amplifiers can be set to function at precise limits, and in reliability of operation, since they have no moving parts.

A single main drive shaft, coupled to the drive motor and to the drive pinion of the transmission assembly, provides direct, positive actuation of the tap changing switches. Devices for operating position locating switches, position indicator, operation counter, etc. are mounted on the main shaft, holding the number of gears required to a minimum.

Only two Geneva gears are used in the transmission assembly, one to operate the load transfer switch and the other to operate the tap selector switch and, at the



. . . DRY JET FUELS

Jet aircraft now get a new and wider safety margin when their fuels are dried with LINDE Molecular Sieves. Even at high fuel flow rates, water normally absorbed at ground level is reduced to less than 10 ppm — eliminating ice-blocked fuel lines at high altitudes.

Liquids never before dried-successfully by desiccants can now be dried commercially with these new zeolite adsorbents. Examples are acetone and other ketones, ethanol and other alcohols, and most saturated and unsaturated hydrocarbons. Drying to less than 1 ppm is now practical in dynamic systems. Due to their high water adsorbing capacity, LINDE Molecular Sieves bring pronounced savings in investment and operating costs.

No matter what the liquid — whether attempts to dry it have succeeded or failed — we would like to discuss with you what a Molecular Sieve design can do.

Write Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Address Dept. **PR-7**

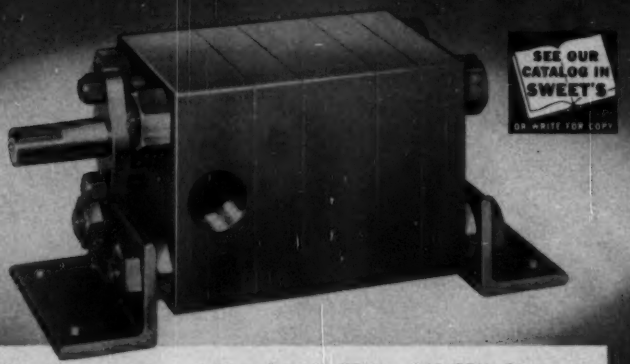
Linde
MOLECULAR SIEVES

UNION CARBIDE

"Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation.

NORTHERN NITRALLOY PUMPS

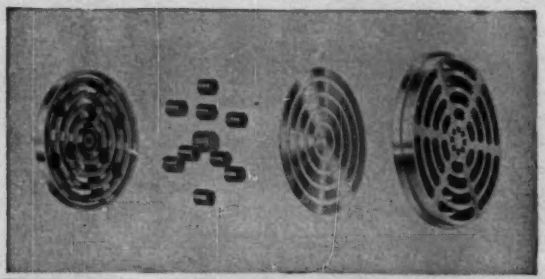
Lube oil, seal oil and fuel oil pumps for compressors and engines



Complete range in pump sizes from ¼ GPM to 146 GPM. Pressures to 2000 PSI. Proven in thousands of installations and backed by 50 years of engineering and production experience, Northern Steel Block Nitralloy Rotary Gear Pumps are unexcelled for precision manufacture, accurate assembly and dependable, long life operation. Write for free catalog and engineering data.

NORTHERN ORDNANCE, INCORPORATED
Subsidiary
NORTHERN PUMP COMPANY
MINNEAPOLIS 21, MINN.

VOSS VALVES in your machine mean



LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

- up to 40% more valve area • minimum pressure loss • higher efficiency
- less power consumption • normal discharge temperature
- quiet, vibration-free • utmost safety • lower operating costs

VOSS VALVES are made to specification, machined from solid stock (not cast)—using best alloy steels; for corrosion condition—stainless steels, such as 410, 18-8 or non-ferrous alloys—monel, inconel, etc. PLATES are machined (not stamped) and ground for precise close tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. SPRINGS of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

J H H VOSS VALVES REG. U.S. PAT. OFF.
J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.

Equipment . . .

proper time, the reversing switch. Mechanical stops on the tap selector gear in addition to electrical stops prevent overtravel in either direction.

A feature of the moving contact shoes of the tap changing switches is their free parallelogram action, which allows them to adjust to, and exert constant pressure on, both sides of the stationary contact blades. All contact parts are made of materials best suited to provide good conductivity and good wear resistance. The contacts of the load transfer switch, the only one which interrupts current, are made of materials selected for their ability to withstand arcing.

Simplification of design and ruggedness of construction is stressed throughout, to make the mechanism accurate, reliable, long-lasting and quiet in operation. Wagner Electric Corp.

Circle E9 green card, last page

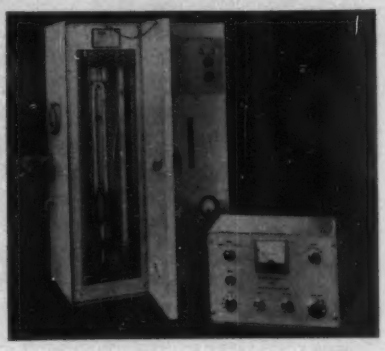
Brochure Compares Ductile Iron And Gray Iron

An 8-page brochure covering a new line of gate valves designed specifically for ductile iron has been released.

The new valve line, which will be known as the Pipe-Pal series, introduces the "spread flange design," which features a high-visibility bonnet joint and extra long bolts for storage of bolting energy.

In addition to listing complete specifications, pressure-temperature ratings, and dimension and material charts, the folder describes newly developed applications for the ductile iron lines. Included also is a discussion of the engineering properties of ductile iron and micro-structure comparisons with gray iron. The Ohio Injector Co.

Circle E10 green card, last page



Gas Chromatography Range Increased With New Unit

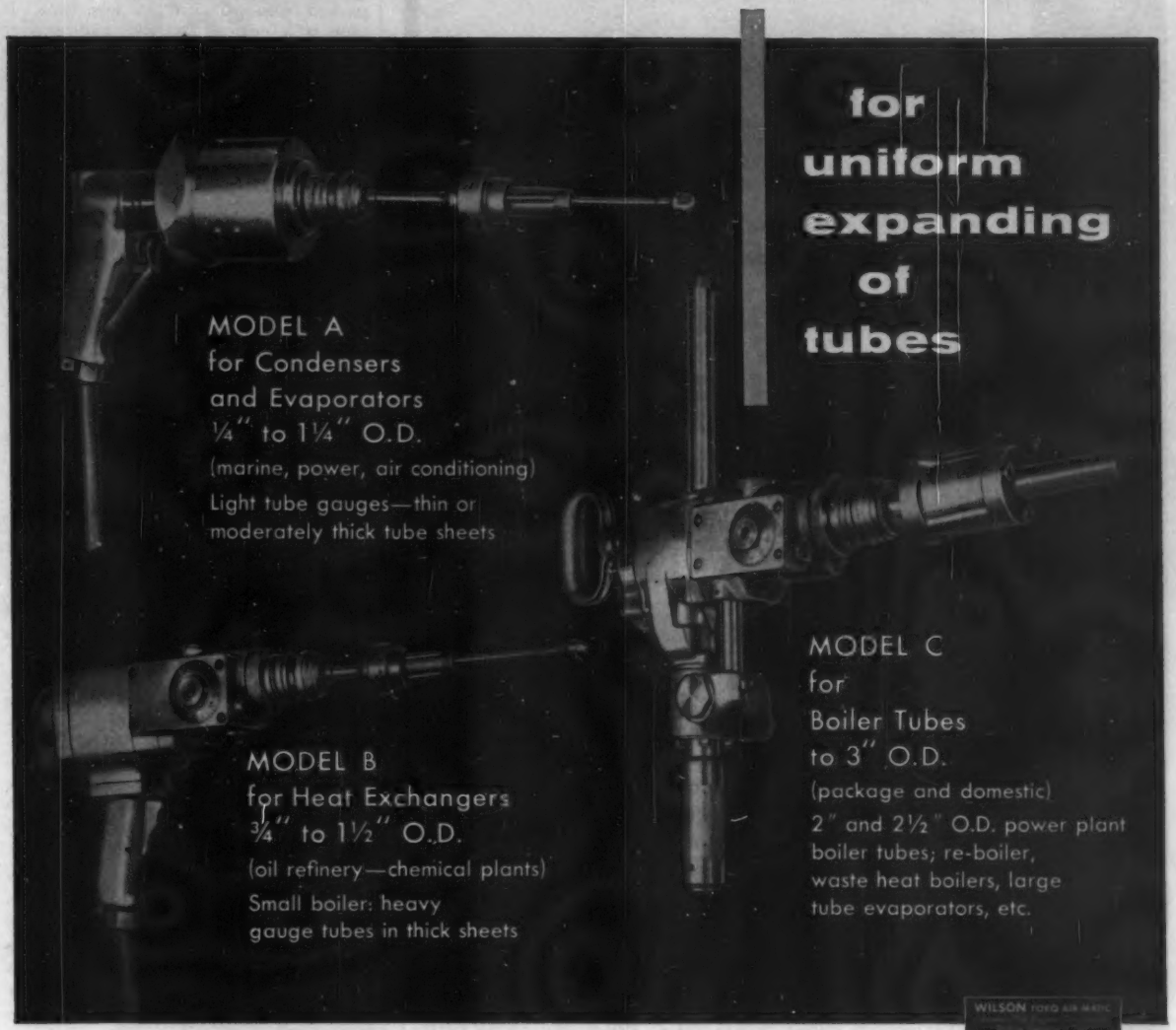
Extremely high resolution and unmatched sensitivity are achieved with a new unit developed for use with Models 154B and 154C Vapor Fractometers. The new unit comprises a Golay Column, an Ionization Detector and an amplifier (photo foreground) to supply the detector circuit.

This combination of the unique Golay column and the new ionization gauge detection systems provides resolution impossible with conventional packed col-

Now...for every tube...every size...every type of job

WILSON TORQ-AIR-MATIC

AUTOMATIC EXPANDER DRIVES


for uniform expanding of tubes
MODEL A
for Condensers and Evaporators
¼" to 1¼" O.D.
(marine, power, air conditioning)
Light tube gauges—thin or moderately thick tube sheets
MODEL B
for Heat Exchangers
¾" to 1½" O.D.
(oil refinery—chemical plants)
Small boiler: heavy gauge tubes in thick sheets
MODEL C
for
Boiler Tubes
to 3" O.D.
(package and domestic)
2" and 2½" O.D. power plant boiler tubes; re-boiler, waste heat boilers, large tube evaporators, etc.

Now WILSON offers a complete line of Torq-Air-Matic automatic tube expander controls. The Wilson Torq-Air-Matic is the first and only air driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel without depending on frictional, ratcheting, magnetic, hydraulic or electrical devices.

THOMAS C. WILSON, INC. 21-11 44th Ave., Long Island City 1, N. Y.
Branch Office: Land Title Building, Philadelphia 10, Pa.
Representatives in principal cities • Cable Address: "Tubeclean," New York

See how the exclusive design features of WILSON Torq-Air-Matic can help you expand tubes accurately and uniformly with considerable savings in time and manpower. Write for your Bulletin No. 581 which gives helpful data.

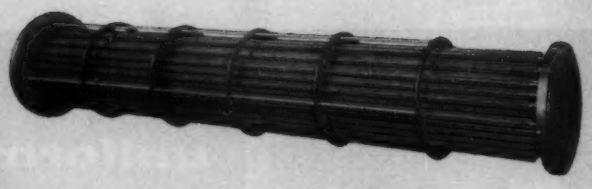
TW-887

WILSON

TUBE CLEANERS • TUBE EXPANDERS

Low-finned
tube design.

All stainless steel longitudinally finned tube bundle with disc and doughnut baffles.



WHITLOCK FINNED TUBE HEAT EXCHANGERS

Note welded tube to tube sheet seal.

Extra heat transfer surface means smaller, more powerful exchangers

To boost heat transfer operations and permit use of more compact units, we supply finned tube heat exchangers which provide many times the surface area of similar exchangers having plain tubes. For many applications finned tube exchangers offer considerable savings in costs when you're buying heat transfer surface — they also conserve installation space. Whitlock's long experience in the design and building of heat transfer equipment includes use of finned tubes as well as many other constructions, materials, and fabricating techniques. Ask our engineers to recommend the heat exchanger for *your* job.

● **A Few Whitlock FINNED TUBE Applications**

Reboiler	Condenser	Inter-Cooler
After Cooler	Air Cooler	Oil Heater
Heater	Gas Cooler	Oil to Oil Heat Exchanger

Whitlock

THE WHITLOCK MANUFACTURING CO.
75 South Street
W. Hartford 10, Conn.
In Canada:
Darling Brothers, Ltd., Montreal

See us at our Booth — Third National Joint Heat Transfer Conference, University of Conn. Aug. 10-11-12, 1959.

DESIGNERS AND BUILDERS OF BENDS, COILS, CONDENSERS, COOLERS, HEAT EXCHANGERS, HEATERS, PIPING, PRESSURE VESSELS, RECEIVERS, REBOILERS

Equipment . . .

umns and thermal-conductivity detector. Also provided is sensitivity to minute components. Without multistage devices and backflushing, it will deliver a rapid evaluation of a wide boiling range of samples. The new unit is normally capable of producing chromatograms with at least five times better resolution than packed columns—and in less time. If time is a critical factor it can provide resolution equal to that of packed columns in a tenth of its normal operating time. Perkin-Elmer Corp.

Circle E11 green card, last page

Bulletin Gives Data On Finned-Tube Exchangers

Advantages and performance characteristics of Alcotwin longitudinal finned-tube heat exchangers and thermal heaters are described in a new bulletin.

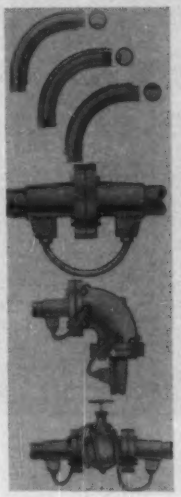
The exchangers offer high heat-transfer rate and fluid flow at low cost, together with interchangeability within a plant and "off-the shelf" availability.

Sections of the bulletin are devoted to dimensions, mechanical specifications, physical data of steel and non-ferrous heat exchangers, and finside coefficient and pressure drop. ALCO Products, Inc.

Circle E12 green card, last page

Fittings Designed For Steam Traced Piping System

Three new components and increased maximum size for a unique piping system with integral steam tracing has been announced.

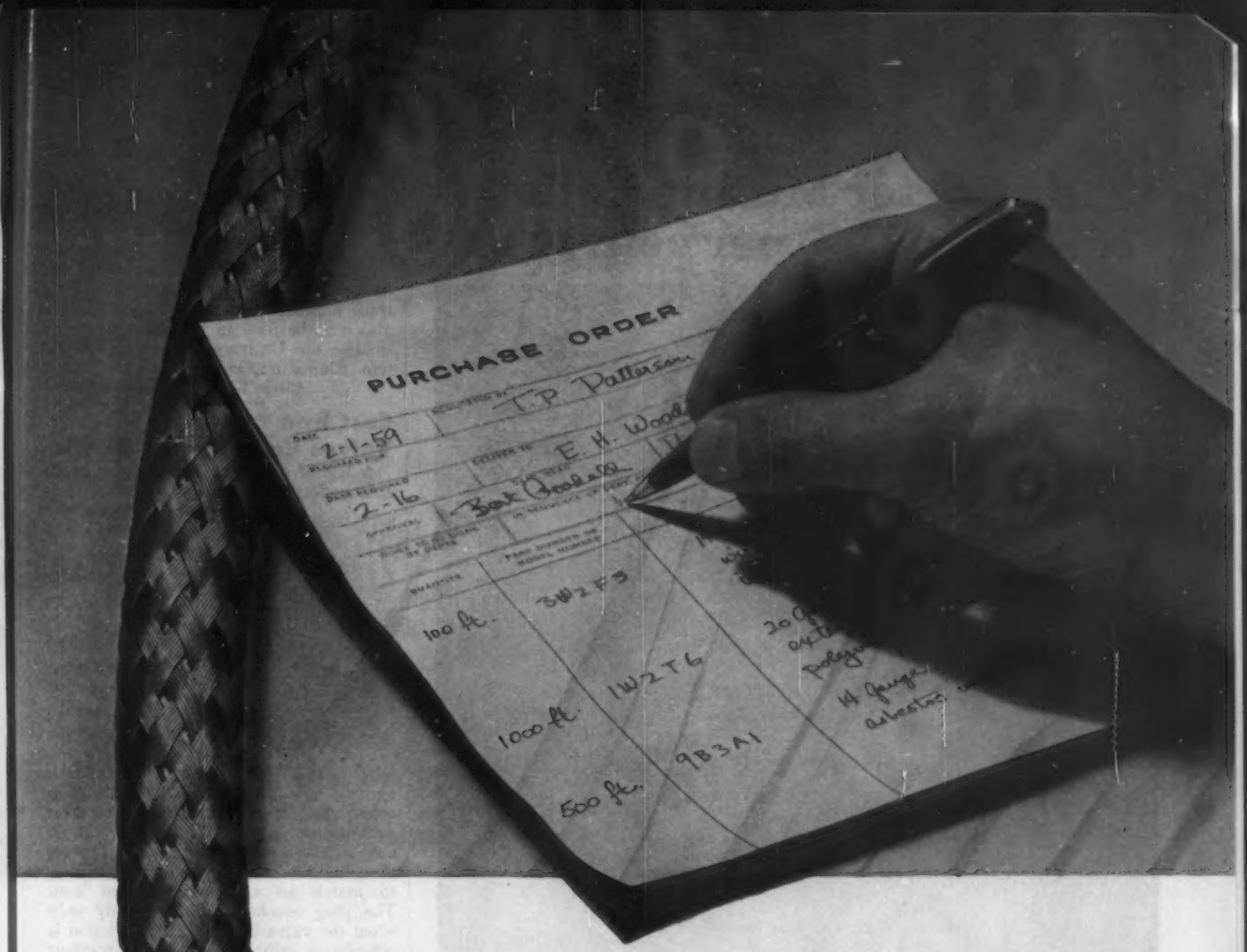


Unitrace is available with an outside diameter equal to 8-inch pipe, increasingly larger sizes are demanded to handle economically such bulk material as fuel oil, urea and asphalt.

The family of fittings developed to incorporate Unitrace into standard piping systems now includes a new flange, adapter flange, and 90-degree elbows.

The new flange, cast in alloy 356-T7, makes possible simple and efficient joining of the sections. The trace line first is cut back. The product line then is inserted into the flange, and welded at the neck and front face. Steam is led around a flanged joint by a jumper line threaded into a connection in each flange bottom. When steam is introduced, a special impingement plate prevents erosion of the product pipe.

Unitrace 90-degree elbows, extruded in alloy 6063-T5, facilitate installation in areas requiring a number of right-angle turns. Elbows are supplied with trace sections cut back, to simplify their being welded into the system. After installa-



Write your own ticket for Honeywell thermocouple wire

Choose from over 100 variations of insulated thermocouple wire and thermocouple extension wire. Honeywell can supply it from stock, with insulation in any of the conventional combinations of asbestos, glass, polyvinyl, Teflon and others. Should your application require other than conventional insulation, Honeywell can custom-make what you need, quickly and economically.

Call your local Honeywell field engineer . . . he's as near as your phone. Or write for Buyer's Guide C100-8.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

First in Control

FOR CATALYST BED SUPPORT:

This Porter Mullite Pellet costs up to 50 per cent less!

Porter Mullite Pellets actually do cost up to 50 per cent less than most catalyst bed support materials now available. *And you make no operational sacrifice to gain this savings!*

Porter mullite pellets have been commercially tested for over three years, as inert support for active catalyst, in many major refineries. They've withstood all the trials of heat, shock and pressure without breaking or dusting. Porter mullite pellets have successfully resisted abrasion, erosion and crushing . . . completely protecting the valuable catalysts from contamination.

Convert to Porter mullite pellets now, and reflect these important cost-savings in your refining process. For complete information, write: *Refractories Division, H. K. Porter Company, Inc., Porter Building, Pittsburgh 19, Pennsylvania.*

REFRACTORIES PORTER DIVISION

H.K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Copper and Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION, H. K. PORTER COMPANY de MEXICO, S. A.; and in Canada, Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.

Equipment . . .

tion, the traces are joined and sealed with trace caps.

Many heated piping systems use jacketed valves and fittings with flange bolt circles one size larger than the pipe size. Unitrace now can be joined to these bolt circles with an adapter flange, which has flange circles one size larger than Unitrace nominal pipe size. Adapter flanges also may be used to introduce larger or smaller size Unitrace sections into a system. Aluminum Co. of America.

Circle E13 green card, last page

Cast Iron Eccentric Valves Coated With Plastic

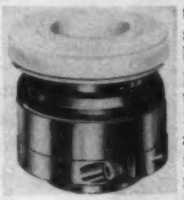
A line of eccentric valves is now available with plastic coatings. The coatings greatly improve the corrosion resistance of a cast iron valve at only a slight increase in price, says the company.

The plastic coatings make the valve especially suitable for neutral salt solutions, alkalies, alkaline salts, mild acids and many other services. They are also an economical answer to iron contamination in water distillation, demineralization and deionization systems. They work on an unique eccentric principle which pivots the plug eccentrically in the valve body to match an eccentrically-raised seat. The plug touches the valve body only when the valve is closed. Plug friction is completely eliminated. Their resilient faced plug eliminates the need for lubrication to achieve tight shut off. De Zurik Corp.

Circle E14 green card, last page

Mechanical Seal Resists Sulfuric Acid Corrosion

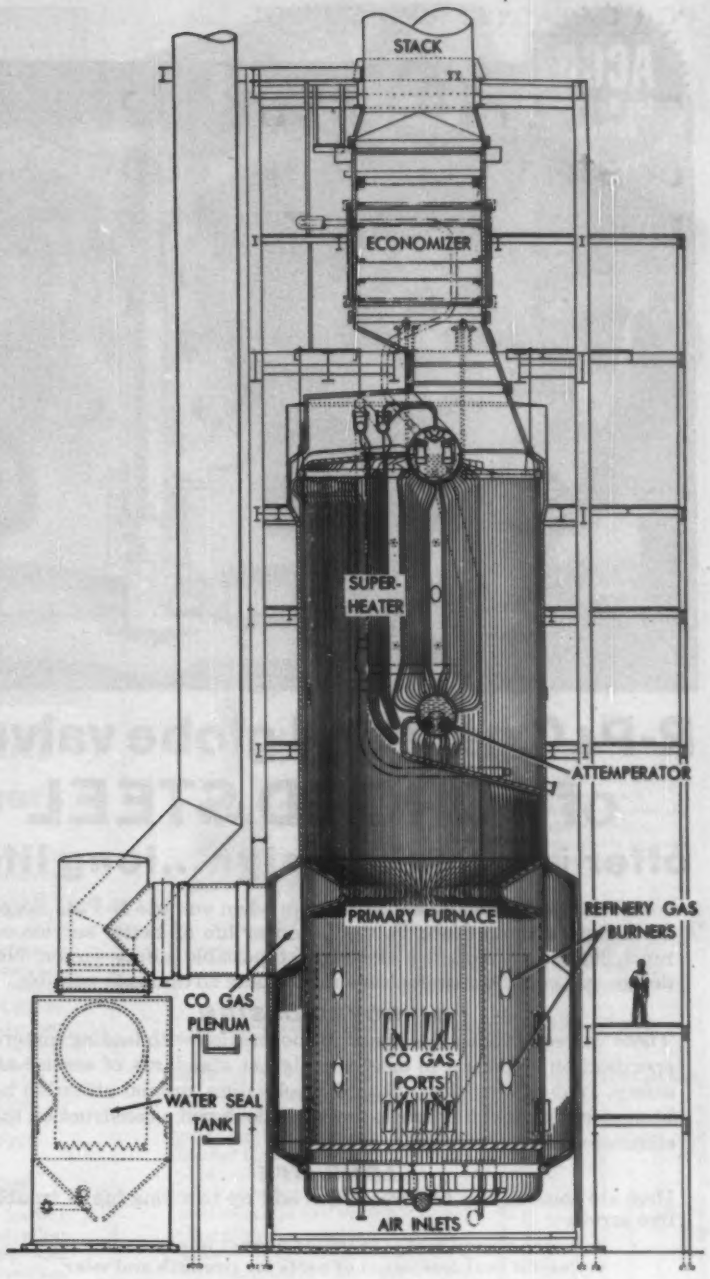
The Kolker Chemical Corp. experienced much difficulty in maintaining seals in acid service pumps used to circulate highly concentrated (98 percent) sulfuric acid to scrubbing towers. Since the pumps, stainless steel units handling about 20 gpm of the acid at an 80 foot head, are in 24-hour service, a night failure of a seal often results in a shutdown of a scrubbing tower for eight to twelve hours, causing contaminated product and additional process interruptions in subsequent operations.



Two different styles of seals were tried and they failed because of, (1) severely corrosive operating conditions affecting metal parts of seal, or (2) the circulating acid used for scrubbing picks up a reaction by-product granular in nature causing excessive wearing of the seal faces. Even during the relatively short life of these seals, much adjustment was needed to keep leakage within limits. One cause of severity of this service is the high tem-

Refinery Report: **CO 15**

Converting Waste to profit for SOHIO



This is a Babcock & Wilcox CO Boiler.

It was purchased by The Standard Oil Company (Ohio) for their ultra-modern, completely-integrated refinery in Toledo, Ohio.

It is designed to use the heat in waste CO gases from the cracking unit to generate steam for the refinery's power and process needs.

It does just that. Hour after hour. Day after day. Week after week. Dependably and efficiently.

It will save enough fuel to pay for itself in less than 3 years.

Probably, a B&W CO Boiler can do the same for your refinery.

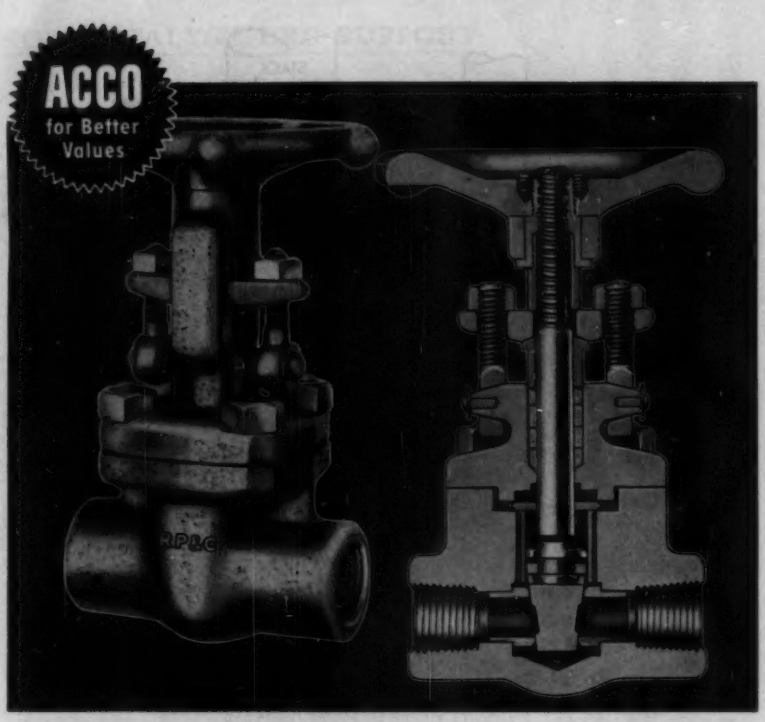
Find out. Write us today. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

CO-103



R-P&C gate and globe valves of FORGED STEEL

offer improved design...long life!

• You get these substantial benefits when you use R-P&C Forged Steel Gate and/or Globe Valves: a longer life of better service... a much lighter valve...plus the highest possible safety factor. New design and construction features make these advantages possible.

IMPROVED DESIGN

These valves have been designed in cooperation with leading material specification engineers to meet the highest standards of service and safety. In designing these Forged Steel valves, special attention has been given to providing ample metal sections and a construction that eliminates unnecessary bulk and weight.

LONG LIFE

Here are some design features which add up to a long life of trouble-free service:

A. **Spiral-wound gasket in bolted bonnet joint**
B. **Careful heat treatment of parts for strength and wear**
C. **Unique stem design to protect stuffing box packing**
D. **High quality materials to prevent corrosion**
E. **Precision manufacture with exacting standards**

A COMPLETE LINE

R-P&C Distributors offer users in the petroleum industry—in addition to these outstanding Forged Steel valves—a complete line of R-P&C gate, globe and angle valves in all standard materials: electric furnace iron, bronze, bar stock, cast steel...plus many specialties. See your nearest R-P&C Distributor—or write—

R-P&C VALVES ACCO

R-P&C Valve Division, American Chain & Cable Company, Inc.

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

Equipment . . .

perature generated during process upsets. Normal operating temperatures vary between 35°C and 70°C, but temperature at the seal face might reach 100°C during an upset. Seal replacement costs for a single pump was about $200 per year.

Solution. A new type of corrosion resistant high temperature mechanical seal called the chemiseal was tried. It is a chemically impervious, pressure balanced seal with a spring-loaded Teflon bellows. It is capable of operating at 75°C at 100 psi or 100°C at 75 psi and shaft speeds up to 2,000 fpm without cooling. After installation of this new seal, there was no downtime for maintenance for more than 27 months. The Garlock Packing Co.

Circle E15 green card, last page

Plastic Pilot Speeds Exchanger Retubing

Light, easy-to-handle tube pilots, costing approximately one-tenth as much as previous models, have been developed. The new "Guide-Rite" pilots are for use with heat exchanger and boiler tubes ranging from ⅜ to 1 inch O.D.

Tube pilots are used to speed assembly of tubular equipment by piloting tubes through tube sheets, baffles, and support plates. Piloting prevents damage to tube ends and eliminates the need to fish tubes through mis-aligned tube holes.

The new pilots are made entirely of plastic. They are designed to do the same job, within their application range, as much heavier and costlier models. The plastic pilots have a spring pressure feature that holds them securely in place, yet makes removal easy. Thomas C. Wilson, Inc. **Circle E16 green card, last page**

Portable Unit Gathers Process Data On Tape

A trailer-mounted portable unit gathers data from an operating process, and records this information in digital form on tape for computer analysis. The PDR-1 (Process Dynamics Recorder) accepts the output of transducers measuring temperatures, pressures, flows, levels, stresses, etc., directly. It linearizes scale factors and filters data prior to recording on magnetic tape. The unit can sample five separate channels of information at sample speeds up to 40 samples-per-second per channel. It can also accept 60 individual signals and record them at rates up to 2½ seconds per scan. Overall recording accuracy of signals with a 0.001 cps to 10 cps frequency range is 1 percent. The tape output is compatible with commercial computers such as the IBM 650, enabling complete process recording,

move mountains - of AIR!
in towers and exchangers

- Sizes 14′ to 18′
- 4 or 6 blades

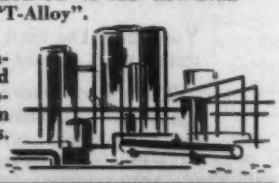
Developed originally for the petroleum industry, Aerovent Large-Diameter "Al-metal" Propellers, constructed of tough, durable aluminum alloy, move great quantities of air at high velocities, in heat exchangers and cooling towers. Pictured above are two 4-blade, 16-ft. propellers in a cooling tower installation. These mighty propellers, with adjustable-pitch "Macheta" Airfoil blades, are job-engineered to individual specifications.

Write for free Bulletin 510

DESIGNED FOR DEPENDABLE OPERATION!

Endurance tests, conducted at *3 times* normal loading prove the ability of these new large-diameter propellers to withstand severe punishment. Heavy-duty cast steel hubs offer maximum resistance to stresses. Angle settings for each operating requirement, and appropriate alternate settings, assure accurate pitch for any predetermined performance which may be required. 54" to 144" now available in revolutionary new "T-Alloy".

REFINERIES, pumping stations, industrial plants and commercial buildings use Aerovent "Al-metal" Propellers in major air-moving applications.



Aerovent FAN COMPANY, INC.
LARGE PROPELLER DIVISION
304 Wright Bldg.
TULSA 3, OKLA.
Main Office and Factory
PIQUA, OHIO

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

MAGNETROL

AS DEPENDABLE AS MAGNETIC FORCE ITSELF

● No matter how specialized the liquid level control application, adapting Magnetrol to meet it presents no problem. Whether it's for high pressures, high temperatures, corrosive liquids or any other condition, a few "standard" modifications and the job is done! Operation is so simple no changes in basic design are needed. That's why Magnetrol "fits" practically any application — why "specials" are so often standard with us.

Because of the utter simplicity and dependability of its magnetic principle, Magnetrol has *infinite operating life.* There are no wearing parts to get out of order.

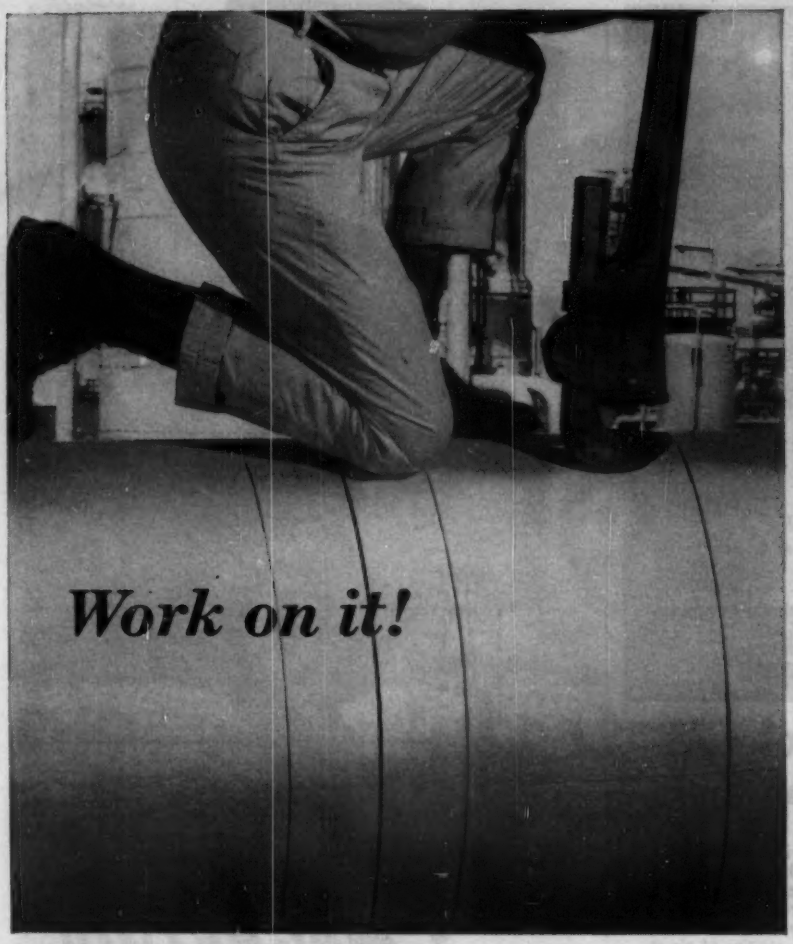
Magnetrols are available for controlling level changes from .0025-in. to 150-ft., with single or multi-stage switching. Our experienced engineering staff is at your service.

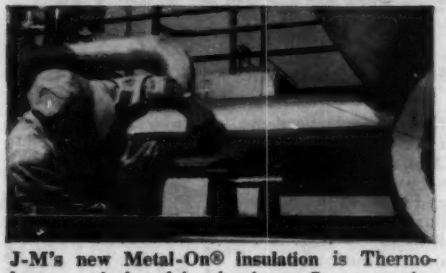
MAGNETROL, Inc.

WHY NOT MAIL THE COUPON — NOW

Magnetrol, Inc., 2112 S. Marshall Blvd., Chicago 23, Illinois 7
Please send me catalog data and full information on Magnetrol Liquid Level Controls.
Name_____
Company_____
Address_____
City_____ Zone_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.





J-M's new Metal-On® insulation is Thermobestos prejacketed in aluminum. Snaps on pipe quickly . . . surely. Saves the time and cost of separate on-the-job metal application.

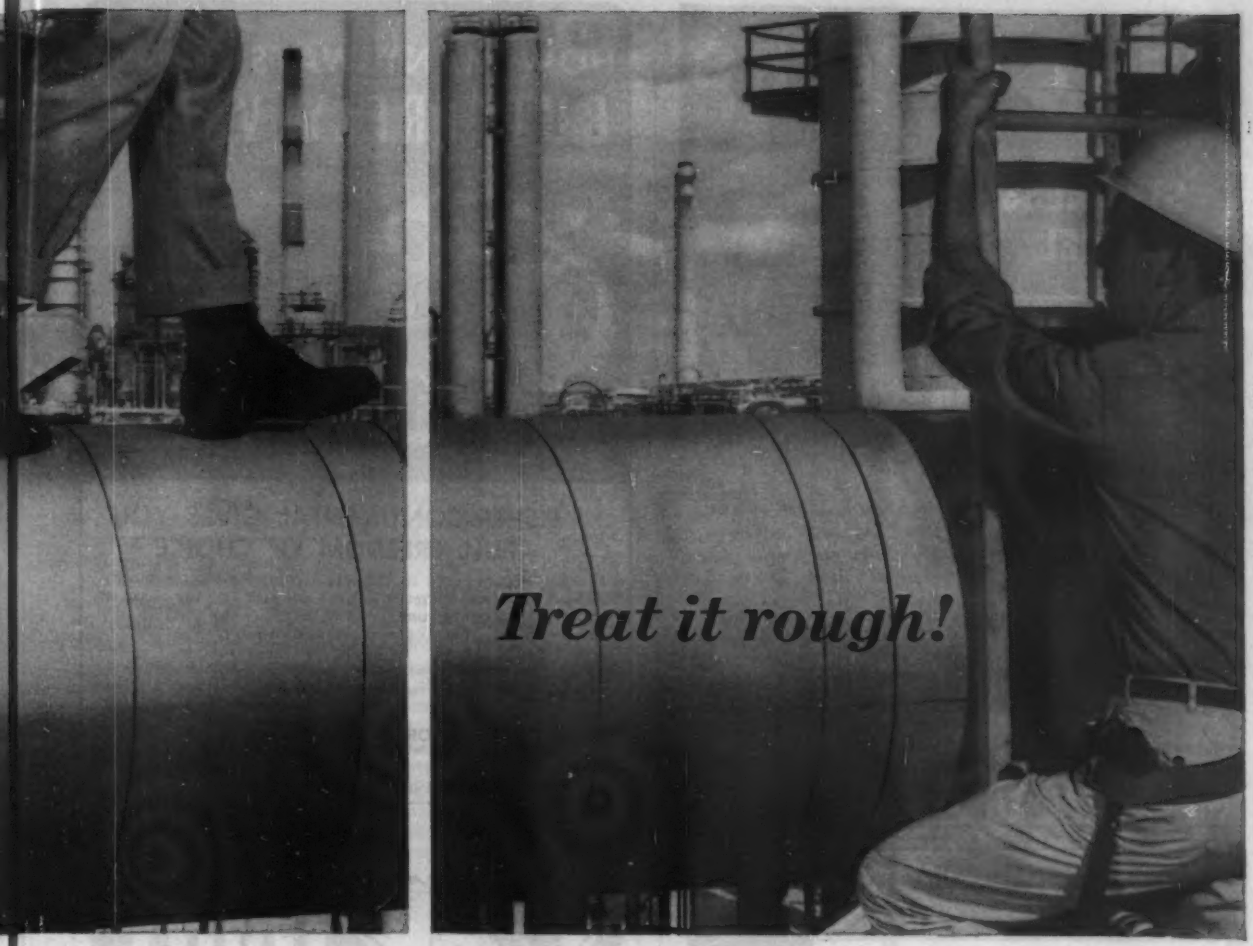
Seminars on best installation practices. For plant foremen who wish to keep up to date on new insulation methods and installation practices, J-M regional sales offices will gladly conduct insulation seminars. Contact nearest J-M office.

It's tough, durable Johns-Manville

Here's why Thermobestos is the preferred high-temperature calcium-silicate insulation . . . to 1200 F

You know the kind of treatment pipe insulation must take . . . day after day, year after year!

There's no better reason than this for the spiraling growth in Thermobestos® applications throughout the process and power generation industries —an insulation so strong and rigid, so resistant to crushing and compression it is almost structural.



THERMOBESTOS insulation!

Equally important is the ability of Thermobestos to keep fuel costs low. Its *k* factor is the lowest of all insulations generally accepted for process applications. Its moisture resistance, unsurpassed.

Furnished in large, lightweight sections—precision-molded to unusually close tolerances—Thermobestos is easy to handle and install . . . readily adaptable to shop fabrication of fittings and bonds. Large selection of sizes, thicknesses (and quads up to 33″ pipe size) permit calcium-silicate installations that are entirely Thermobestos insulation.

You'll want the new Thermobestos booklet for your technical file. It contains complete information on prefabricating and installation practices . . . specification data . . . heat transmission tables . . . and physical and thermal characteristics. Write for it today. Ask for booklet IN-169A. Address Johns-Manville, Box 14, New York 16, N.Y. In Canada, 565 Lakeshore Rd. East, Port Credit, Ontario.

JOHNS-MANVILLE PRODUCTS

JOHNS-MANVILLE

TEST METERS IN STAINLESS STEEL

Specially made for the measurement of small volumes of gases and with special applications in the Petroleum Industry. Robust and easily cleaned.

Type E.40 Wet Meter, 1/10 cu. ft. per rev., 40 cu. ft. per hour, OR alternatively 2½ litres per rev., 1000 litres per hour. Stainless Steel case and drum.

PARKINSON COWAN INDUSTRIAL PRODUCTS

(A Division of Parkinson Cowan Ltd)

PARKINSON COWAN INDUSTRIAL PRODUCTS

Dolphin Works, Fitzalan St., Kennington Road, London, S. E. 11. Tel. Reliance 2406

HOW TO SOLVE *heat transfer problems*

Here is the book to give you a quick view of heat transfer fundamentals and the calculations of applying them in the design of such equipment as feed-water heaters, condensers, boilers, internal-combustion engine cylinders, and fan coils. Emphasizes basic aspects and immediately useful calculations!

Just Published—3rd Edition

Introduction to HEAT TRANSFER

By Aubrey I. Brown and Salvatore M. Marco, both of The Ohio State University

Third Edition, 328 *pages*, 6x9, 70 *illus.*, $6.75

Engineers encountering a growing number of problems in this field will appreciate the directness of the treatment. Third edition includes new chapters on fluid flow in the convection process and graphical and numerical methods applied to heat conduction problems.

Chapter Headings

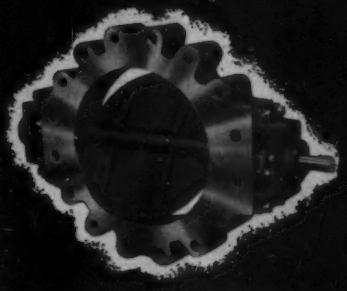
1. Modes of Heat Transfer
2. Heat Transfer by Conduction
3. Equations for the Calculation Conduction of Heat Transfer
4. Radiation
5. Fundamental Units and Dimensional Analysis
6. Fluid Flow in the Convection Process
7. Forced Convection
8. Free or Natural Convection
9. Heat Transfer to Boiling Liquids
10. Condensing Vapors
11. Over-all Transfer of Heat
12. Applications of the Principles of Heat Transfer to Design Problems
13. Transient Conduction
14. Graphical and Numerical Methods for Heat-conduction Problems

The Gulf Publishing Company

P. O. Box 2608

Houston 1, Texas

HOW MANY WAYS CAN A BUTTERFLY VALVE SERVE YOU?



The application of Fisher-Continental Butterfly Valves is virtually limitless in the gas, vapor, liquid or semi-solid flow control industries. These compact, low cost controls fit the specifications of a vast majority of applications.

FISHER-CONTINENTAL GIVES YOU FULL FREEDOM OF CHOICE

For gas, vapor, liquid or semi-solid control problems specify Fisher-Continental Butterfly Valves—any size . . . any metal or alloy . . . any temperature . . . any fluid . . . any pressure . . . any condition . . . any operator, manual or power.

For complete details about Fisher-Continental Butterfly Valves send for free literature.

FISHER GOVERNOR COMPANY

Marshalltown, Iowa/Woodstock, Ontario/London, England

Direct Inquiries To:

CONTINENTAL EQUIPMENT CO. DIVISION, CORAOPOLIS, PENNSYLVANIA

FISHER Controls

SINCE 1880

Don't spoil it- KROIL it!

Don't ruin a valuable piece of equipment merely because some part is rusted tight. Apply *KROIL*, the amazing new chemical lubricant that creeps into millionth inch spaces (proved by laboratory tests), dissolves rust, supplies necessary lubrication and . . .

Loosens Frozen Parts

18,000 of America's leading plants can't be wrong. They have used KROIL for ten years and depend on it to save expensive labor and valuable parts. They say: "Kroil loosened bushings after a 12-ton press had failed" . . . "on repairing heat treat trolleys formerly destroyed every nut. Now Kroil saves them all, and time, too."

You too can get these results. Try KROIL on money-back basis.

Gallon, $4.00; with Kroiler squirt gun, $4.95, f. o. b. factory.

Ask for GENIUS AT WORK—a free publication full of ideas for maintenance men.

KANO LABS. 1094 Thompson Lane Nashville 11, Tennessee

from which operating trends are readily discernible. It can also be used as a portable data logger or control room with typewriter readout. Southwestern Industrial Electronics Co.

Circle E17 green card, last page

Valve With Clamps Makes Dock Hose Connection Easy

A new valve design meets a universal need for an easier and more practical method of connecting cumbersome flexible tanker or barge hoses to manifold valve flanges.

The problem was solved by supplying a valve with one extended flange, allowing the workman plenty of handspace between the valve body and the flange.

Also provided was a nominal number of lugs extending beyond the lower lip of the stationary valve flange face. This addition permits the workman to rest the heavy hose flange until it is properly aligned. With hands freed, the workman need only place the gasket between the flanges, quickly insert the bolts and tighten the nuts.

Then, to even further simplify the operation, modified "C" clamps were designed, and attached to the extended flange. These clamps can make a completely tight joint between the flanges, eliminating the need to align holes or use bolting.

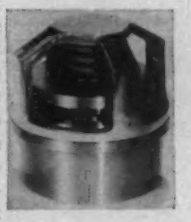
For speed and economy, the lug-clamp combination makes an effective team. Clamps, however, are optional.

Considerable savings in cost of time, labor, and product leakage may be realized by use of this new design. Kerotest Mfg. Co.

Circle E18 green card, last page

Fluid Pump Valve Chatter Eliminated With Lift Valve

Reciprocating fluid pumps operate smoother without valve chatter when equipped with the new FP-7 Tru-Lift Valve.



Patented guide features insure that the valve will always move in a straight-line motion and that the valve will rotate to insure even wear. The valve does not wobble or chatter but operates with a "soft action," so fluid shocks are materially reduced with consequent reduced wear on other pump parts and flow lines.

Wear is distributed over the large guiding and seating surfaces, giving long life even under highly corrosive conditions. The valve is available in all sizes and materials to meet special service requirements in the refining and petrochemical industries. Dixell Development & Mfg. Co. **Circle E19 green card, last page**

Eductor Mixing Of Two Fluids Covered In Bulletin

New Bulletin 2M-S describes a line of Mixing Eductors equipped with regulating spindles. These eductors are designed to perform intimate mixing, blending, or emulsification of two fluids. Most commonly, the fluids handled are two liquids, but they may be a liquid and a gas, or a liquid and a slurry. The regulating spindle provides for throttling of the motive (higher-pressure) liquid flow over a wide range of load conditions. Normally these eductors accomplish mixing without requiring pumping in the suction-fluid line.

Mixing Eductors are available with handwheel operation of the spindle, or with diaphragm motor for automatic control of spindle position. In operation, the motive liquid issues from a nozzle at high velocity and entrains the suction fluid. The two fluids are intimately mixed under extreme turbulence in the throat of the eductor, and discharge at the pressure required for downstream operations. The spindle's throttling is performed in the nozzle, therefore the energy which would be lost through an external control valve is put to work with maximum effect to mix the two fluids. Schutte & Koerfing Co.

Circle E20 green card, last page

All-Transistor Computer Made In Typewriter Size

A new all-transistor analog computer, the Pace TR-10, a compact, portable analog computer which the engineer can use at his own desk, requires only as much area as a standard electric typewriter, and plugs into a common 110-volt AC outlet.

The TR-10, containing 10 operational amplifiers, sells for under $4,000.

By simulating production processes and equipment during the design phase of new refinery construction, big savings have been realized in equipment outlay, and production has frequently been greatly multiplied. Optimum designs can be obtained in a fraction of the normal time required through analog simulation. Complex calculations, often avoided because difficulty of solution, are made practical through the analog computer's ability to handle problems involving second and third order differential calculus or integrations. Electronic Associates, Inc.

Circle E21 green card, last page

120-Page Book Available On Aluminum Welding

A comprehensive survey of techniques used to weld aluminum through the Aircomatic (gas-shielded metal-arc) and Heliweld (tungsten-inert-gas) processes has just been issued.

This 120-page spiral-bound book thoroughly covers the subject, from a brief historical note on the first uses of these processes for welding aluminum to the highly specialized aluminum fabrications which are being welded with them today.

Major topics covered include: weldability of aluminum and its alloys, definitions and technical discussions of the two welding processes, selection of the proper process for certain job applications, descriptions of manual and automatic equipment, welding power supplies, and safety practices.

The book is illustrated with 100 photographs, charts and detailed diagrams of equipment and techniques. Air Reduction Sales Co.

Circle E22 green card, last page

Equipment . . .

CAPACITY

SACHSE ELECTRIC INC.
BATON ROUGE LA.

BARRETT automatic
Filling and Crimping Equipment
for handling greases and other viscous fluids.
- No operator required.
- 100% air operated.

Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.

BARRETT
Manufacturing Co.
P. O. Box 8096, Houston 4, Texas

REFRACTORY HAYDITE
Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.
We sell direct to you.

CONSTRUCTION MATERIALS
CARTER-WATERS
KANSAS CITY MISSOURI
2440 Pennway Phone GRand 1-2570

Advertisers in This Issue

PETROLEUM REFINER, JULY, 1959

*The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1959 Refinery Catalog.

A

*ACF Industries, Inc.
W-K-M Division 83
*Aerovent Fan Co.
Large Propeller Division 311a
*The Air Preheater Corp. 226
*Airetool Manufacturing Co. 198
Allied Chemical Corp.
General Chemical Division 181
Allied Chemical Corp.
Solvay Process Division 33, 280
Alloy Steel Products Co. 273
*Aluminum Company of America 196
*American Brass Co. 299
*American Bridge Division
United States Steel 190-191
American Heat Reclaiming Corp. 27
American Machine & Metals, Inc. 67
American Petroleum Institute 244
American Steel & Wire Division
United States Steel 81
Amoco Chemicals Corp. 97
*The V. D. Anderson Co. 202
Anemostat Corporation of America 275
*Armstrong Machine Works 222
*Audley Engineering Co. Ltd. 34-A
Austin-Western
Construction Equipment Division
Baldwin-Lima-Hamilton Corp. 278
Avondale Marine Ways, Inc. 204

B

The Babcock & Wilcox Co. 61, 199, 309
*Badger Manufacturing Co. 49
*Baldwin-Hill Co. 64
Baldwin-Lima-Hamilton Corp. 215a, 278
*Barrett Manufacturing Co. 315-b
Beckman Instruments, Inc. 218
*Belmont Packing & Rubber Co. 200
Betz Laboratories, Inc. 252-253
The Bird-Archer Co. 258
*Black, Sivalls & Bryson, Inc. 237
*Blaw-Knox Co. 11, 04
*Bridgeport Brass Co. 21
The Bristol Company 34
British Ermeto Corp., Ltd. 34-B
Brown & Root, Inc. 284
*Buell Engineering Co. 8

C

*Calumet & Hecla, Inc. 211-214
*Campo Fittings, Inc. 261
Cape Asbestos Co., Ltd. 38
Carter-Waters Corp. 315-c
*Catawissa Valve & Fittings Co. 290-b
Cathodic Corrosion Control Ltd. 34-Lb
Chicago Bridge & Iron Co. 26
*Chicago-Wilcox Mfg. Co. 296-b
*Chikaan Co. 43
Classified Advertising 297
Cockburns Limited 34-C
Columbia-Geneva Steel Division
United States Steel 81
Conduit Nipple Mfg. Co. 296-a
*The Cooper-Bessemer Corp. 90-91
*Coppus Engineering Corp. 28

D

Davison Chemical Division
W. R. Grace & Co. 106
Daystrom Systems 301
Dowell 106
*Dresser Industries, Inc. 4
*The Ducon Co. 295
E. I. du Pont de Nemours & Co. 247-248

E

Eastman Chemical Products, Inc. 65
Thomas A. Edison Industries
Instrument Division McGraw-Edison 105
The Electric Controller & Mfg. Co.
Division of The Square D Co. 52
Electronic Associates, Inc. 221
Ellerbee Brothers 206-b
*Elliott Co. 194-195, 250, 282-283, 294
Ethyl Corp. 16-17

F

*Falk Corp. 293
*Fisher & Ludlow Ltd. 34-D
Fisher Governor Co. 94-95, 314-b
*Flexitallic Gasket Co. 193
*The Fluor Corp. 22-23
Fluor Products Co.
Division The Fluor Corp. 2
*Food Machinery & Chemical Corp. 285
Forge & Fittings Division
H. K. Porter Company, Inc. 274
*Foster Wheeler Corp. 33
The Foxboro Co. 20
Fram Corp. 96
*Frick Co. 215-b

G

Gardner-Denver Co. 279
*The Garlock Packing Co. 292
General Chemical Division
Allied Chemical Corp. 181
General Controls 32
Genesys Corp. 183
Claud S. Gordon Co. 276
*Goulds Pumps, Inc. 31
W. R. Grace & Co. 106
Gray Tool Co. 188
*Grinnell Co. 287
*The Griscom-Russell Co. 260
Gulf Publishing Co. 34-Mb, 314-c, 281

H

Hammel-Dahl Division
General Controls Co. 32
*The Harshaw Chemical Co. 209
Head Wrightson Processes Ltd. 34-F
*Hendrick Manufacturing Co. 255
Houdry Process Corp. 210-a
Humble Oil & Refining Co. 259

I

Independent Engineering Co. 290-a
*Ingersoll-Rand Co. 101
The International Nickel Co. 185

J

Jefferson Chemical Co. 265
*Jerguson Gage & Valve Co. 210-b
*Jo-Bell Products, Inc. 197
*Johns-Manville Corp. 40, 312-313
*Jones & Laughlin Supply Division 98-99

K

Kane Laboratories 314-d
The M. W. Kellogg Co. 12, 39
*Richard Klinger Ltd. 35
*Koch Engineering Co. 319
Koppers Co. 234

L

Langley Alloys Ltd. 34-H
Lapp Insulator Co. 79
*Larkin Packer Co. 42
Lawrence Pumps, Inc. 302
Layne & Bowler, Inc. 217
Leeds & Northrup Co. 77
Lenape Hydraulic Pressing & Forging Co. 286
Warner Lewis Co.
Division Fram Corp. 96
LimiTorque Corp. 75
Linde Company
Division Union Carbide Corp. 58, 203, 303
*The Lummus Co. 179, 238-239

M

M.A.N. Maschinenfabrik
Augsburg-Nurnberg A.G. 37
Madsen Works Construction
Equipment Division
Baldwin-Lima-Hamilton Corp. 215-a
*Magnetrol, Inc. 311-b
The Marley Co. 201
*Jas. P. Marsh Corp. 78
McGraw-Edison 105
Arthur G. McKee & Co. 14
Metropolitan-Vickers Electrical Co. Ltd. 34-I
*Mine Safety Appliances Co. 229
Minneapolis-Honeywell 57, 251, 307
*W. K. Mitchell & Co. 93
*Mixing Equipment Co. 263
*Samuel Moore & Co. 25
Mueller Co. 45

N

Nalco Chemical Co. 46-47
Nash & Thompson Ltd. 34-Ma
National Tube Division
United States Steel 81
New England Valve Corp. 267
Newalls Insulation Co Ltd. 36
W. H. Nicholson & Co. 76
Northern Ordnance, Inc. 304a
*Norton Co. 44

O

*Oakite Products, Inc. 289
*Oil Well Supply Division
United States Steel 6
Orbit Valve Co. 205

P

*Pacific Pumps Inc
One of the Dresser Industries 4
Pacific Tube Co. 189
Parkinson Cowan Industrial Products 314-a
*Peerless Pump Division
Food Machinery & Chemical Corp. 285
Pennsalt Chemicals Corp. 104
*Petreco Division
Petrolite Corp. 56
*Petroleum Refiner 80
*The Pfaudler Co
Division Pfaudler Permutit, Inc. 230
*Phelps Dodge Copper Products Corp. 18-19
Phelps Dodge Refining Corp. 266
Philadelphia Gear Corp. 75
Plenty & Son Ltd. 34-K
H. K. Porter Company, Inc. 107, 274, 308
*Posey Iron Works, Inc. 269-b
Horace T. Potts Co. 30
The Wm. Powell Co. 62-63
J. F. Pritchard & Co. 72
Procon Incorporated 74

R

*R-P & C Valve Division
American Chain & Cable 310
Redheugh Iron & Steel Co., Ltd. 34-La
*The Refinery Catalog 50-51
Refractories Division
H. K. Porter Company, Inc. 306
*Republic Steel Corp. 186-187
The Ridge Tool Co. 100-a
*Rockwell Manufacturing Co. 270-271
*Rockwood Sprinkler Co. 73

S

Sachse Electric Inc. 315-a
St. Mary Iron Works, Inc. 100-b
*Sarco Company 71
*Schutte & Koerting Co. 100-c
Serck Tubes Ltd. 268
Shand & Jurs Co. 85
*M. B. Skinner Co. 300
Solvay Process Division
Allied Chemical Corp. 53, 280
Southwestern Industrial Electronics Co. 269-a
Speedline Stainless Steel Fittings Division
Horace T. Potts Co. 30
The Square D Co. 52
Stauffer Chemical Co. 24
The Stearns-Roger Mfg. Co. 68
Stockham Valves & Fittings 60
*Strahman Valves, Inc. 208a
*Stratford Engineering Corp. 59
*Sun Shipbuilding & Dry Dock Co. 29

T

*Taylor Instrument Companies 82
Tennessee Coal & Iron Division
United States Steel 81
*The Terry Steam Turbine Co. 70
Thermoid Division
H. K. Porter Company, Inc. 107
John Thompson Ltd. 34-G
The Timken Roller Bearing Co. 41
*Tretolite Co.
Division Petrolite Corp. 66

U

*Union Asbestos & Rubber Co. 69
Union Carbide Corp. 58, 203, 303
Union Wire Rope Corp. 88
United States Gasket Co. 262
*United States Gauge Division
American Machine & Metals, Inc. 67
U. S. Hoffman Machinery Corp. 206-207
United States Rubber Co. 48
United States Steel Corp. 6, 81, 190-191
United States Steel Export Co. 81
United States Steel Supply Division
United States Steel 81
Universal Oil Products Co. 54-55, 257

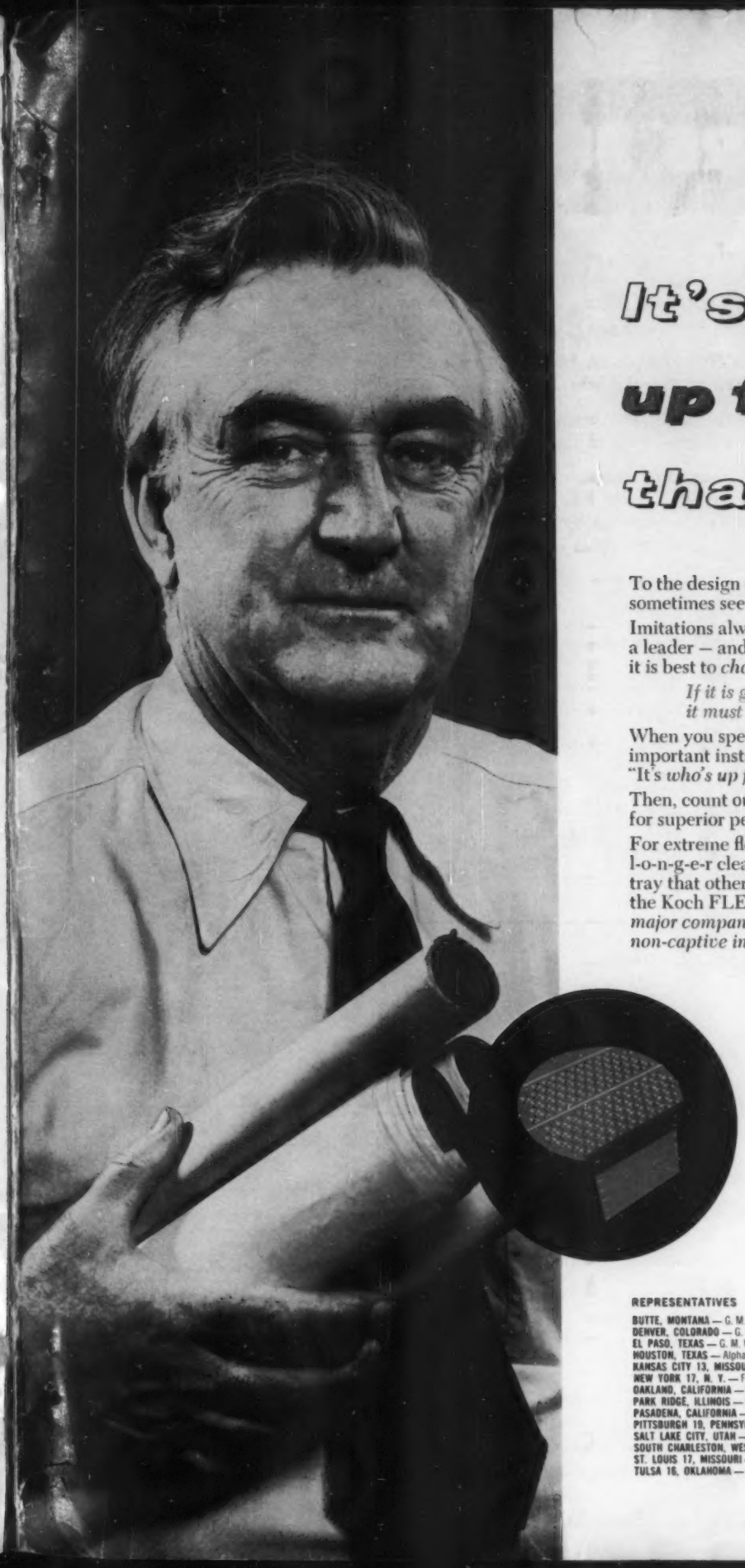
V-Z

*Henry Vogt Machine Co. 233
*Vokes Genspring Ltd. 34-E
*J. H. H. Voss Co. 304-b

*Wagner Electric Co. 291
Warren Petroleum Corp. 240
Western Supply Co. 225
Whitlock Manufacturing Co. 306
*A. R. Wilfley & Sons, Inc. 89
*Thomas C. Wilson, Inc. 305
*Wolverine Tube Division
Calumet & Hecla, Inc. 211-214
Worcester Valve Co. 102-103
Wyatt Metal & Boiler Works 320

*Yarnall-Waring Co. 92
*Yuba Consolidated Industries, Inc. 86-87

*Zallea Brothers 272



It's who's up front that counts

To the design engineer, "follow-the-leader" sometimes seems to be an industrial pastime.

Imitations always appear on the market to follow a leader – and, when they do, it is best to *choose the leader*, because:

If it is good enough to imitate,
it must be superior!

When you specify fractionating trays for your next important installation, keep in mind that, "It's *who's up front* that counts"!

Then, count on Koch FLEXITRAYS for superior performance!

For extreme flexibility, higher capacities, and l-o-n-g-e-r cleaning cycles, specify the superior tray that others chose to copy – the Koch FLEXITRAY . . . *now in use by major companies in more than 1,000 non-captive installations!*

Write, wire, or phone your nearest Koch representative or

KOCH

ENGINEERING COMPANY, INC.
321 W. Douglas Ave., Wichita 2, Kansas

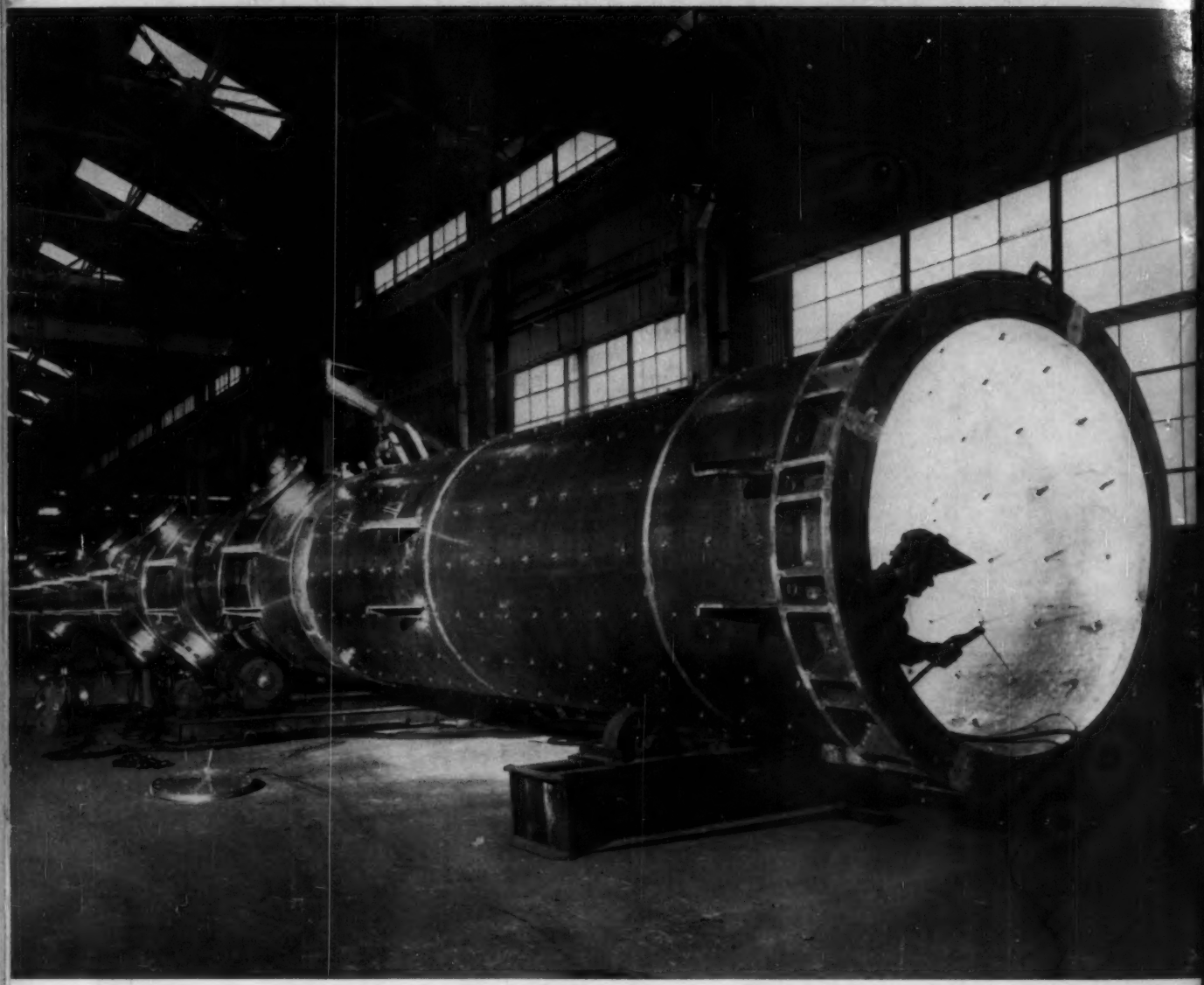
"Continuing progress through research"

REPRESENTATIVES

BUTTE, MONTANA — G. M. Wallace & Co., P. O. Box 208
DENVER, COLORADO — G. M. Wallace & Co., 324 Denham Bldg.
EL PASO, TEXAS — G. M. Wallace & Co., Suite 511, Electric Bldg.
HOUSTON, TEXAS — Alpha Engineering Co., P. O. Box 12371
KANSAS CITY 13, MISSOURI — Sample Brothers, P. O. Box 7061
NEW YORK 17, N. Y. — F. J. McConnell Co., 60 East Forty-second St.
OAKLAND, CALIFORNIA — Engineered Process Equip. Co., 600 Sixteenth St.
PARK RIDGE, ILLINOIS — M. B. Fisher, 1521 Courtland Ave.
PASADENA, CALIFORNIA — Engineered Process Equip. Co., 774 East Green St.
PITTSBURGH 19, PENNSYLVANIA — D. D. Foster Company, 2210 Koppers Bldg.
SALT LAKE CITY, UTAH — G. M. Wallace & Co., Continental Bank Bldg.
SOUTH CHARLESTON, WEST VIRGINIA — D. D. Foster Co., 411 "D" St.
ST. LOUIS 17, MISSOURI — Sample Brothers, 2010 Big Bend Blvd.
TULSA 16, OKLAHOMA — Myers-Aubrey Co., P. O. Box 5436

Master Craftsmanship

IN THE FABRICATION OF ALL THE METALS AND THEIR ALLOYS



Solid aluminum urea stripper tower being completed in Wyatt's Dallas shops.

Wyatt's
HOUSTON - DALLAS
CORPUS CHRISTI - MEXICO CITY

MANUFACTURERS AND ERECTORS SINCE 1913

WYATT METAL & BOILER WORKS, INC.

MANUFACTURING PLANTS

Houston • Dallas • Corpus Christi • Mexico City

SALES OFFICES

Houston • Dallas • Corpus Christi • Tulsa • New York
Philadelphia • Pittsburgh • Los Angeles • Mexico City

SUBSIDIARY

Wyatt's Plastics, Inc.
Houston and Wallis

AFFILIATE

Wyatt de Mexico S.A. de C.V.
Mexico 1, D.F.